CALIFORNIA SMART TRAVELER SYSTEM

Final Report
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ABSTRACT

Both the Federal Transit Administration (FTA) and California's Department of Transportation (Caltrans) have established Advanced Public Transportation Systems (APTS) programs to investigate ways that Intelligent Vehicle-Highway Systems (IVHS) technologies (i.e., computers, telecommunications and other electronics devices) can be used to improvethe cost-effectiveness of local and regional public transportation services.

This report describes how audiotex and videotex information systems can -be used to develop new modes of public transportation (e.g., parataxis or single-trip carpools) and how these new modes can be integrated with conventional transit, paratransit and ridesharing modes to reduce traffic congestion, gasoline consumption, air pollution and mobility problems at a low cost to taxpayers.

This report also describes how these telephone-based information services can be used to develop low-cost, user-friendly Advanced Traveler Information Systems (ATIS) that will tell drivers and riders the "best" ways to get between any two points in an area via either private vehicle or public transportation. The proposed California Smart Traveler (CST) System will enable travelers to obtain more timely and accurate information on which to base their local or regional travel decisions.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

This is the final progress report of a four-person month study to evaluate sites in California for testing audiotex/videotex-based Advanced Traveler Information Systems (ATIS) and Advanced Public Transportation Systems (APTS) concepts. There are three major reasons for developing the California Smart Traveler (CST) System:

1. To develop new types of public transportation services, particularly ones that are well suited to low-density suburban and rural areas, such as single-trip carpools (aka parataxis).

2. To integrate these new services with conventional transit, paratransit and ridesharing modes, in order to improve the cost-effectiveness of local and regionalpublictransportation systems.

3. To provide drivers and riders with more timely and accurate information on which to base local and regional travel decisions.

CST is designed to be user-friendly. By pressing one or two buttons on a touch-tone telephone (i.e. audiotex) or on a computer terminal connected to a telephone line (i.e. videotex), a traveler will soon be able to find the best ways to get between two points by public transportation or by driving. Analysis of available market research data indicates that systems like CST can reduce traffic congestion, gasoline consumption, air pollution and mobility problems at a low cost to taxpayers.

The following is a brief description of the five sites recommended by Aegis Transportation Information Systems Inc. (Aegis) to Caltrans and FTA for possible operational testing of parataxi services and other Advanced Traveler Information Systems (ATIS) concepts in traffic congestion or air quality problem areas of California. These recommendations were made after data collection, analysis, and discussions with local and regional business, government and community leaders:

1. Tri-Valley - This low-density suburban area in San Francisco's East Bay includes the communities of San Ramon, Pleasanton, Dublin and Livermore. The Tri-Valley -area contains the intersection of I-580 and I-680, which are both experiencing growing traffic congestion problems. Major employers in the Tri-Valley area include UC Lawrence Livermore Laboratory, Sandia Corporation, Chevron USA, Pacific Bell and AT&T. Other important employers in the area include EG&G and US West's Public Safety Group,.which designs and develops 9-l-l systems. Because of (a)'the high-tech backgrounds of the employee base and the high density of personal computers, (b) the innovativeness of local governments (e.g. Pleasanton and San

Ramon were among the first communities in the U.S. to adopt traffic mitigation ordinances), and (c) the lack of good suburb-to-suburb transportation services, the Tri-Valley area would be an excellent test site for audiotex-based and/or videotex-based parataxi services involving up to 20,000 employees and their families.

2. UCLA/Westwood - This high-density suburban area lies within the city limits of Los Angeles, near the intersection of the San Diego Freeway, (I-405) and the Santa Monica Freeway' (Highway 10). Both of these freeways and the neighboring arterials have major traffic congestion problems. In fact, the City of Los Angeles has limited the growth of UCLA until Westwood's traffic congestion problems can be reduced. Because *of* the high ownership of personal computers (Pcs) by UCLA'S faculty, staff and student body, this area would be an excellent test site for operational tests of "smart" buses, mini-buses, vans and taxis and audidtex/videotex-based Advanced Traveler Information System (ATIS) concepts involving up to 30,000 local residents, employees and students.

3. North City TMA - This rapidly-growing, medium-density, suburban employment and residential area in San Diego is bounded by Highway 52 to the South, the Pacific Ocean to the West, Del Mar Heights Road'to the North and Camino Santa Fe to the East. Major employers include SAIC, UC-San Diego, University Town Centre, Scripps Memorial Hospital and First Capital Life Insurance. These and other employers have established the North City Transportation Management Association (TMA), which provides collectively-financed products and *services* designed to meet the needs of over 40,000 employees in the area. Because of (a) this hard-working and imaginative TMA, (b) the lack of good public transportation for suburb-to-suburb travel, and (c) a large retirement community in LaJolla, the North City area could provide several groups of 5,000-10,000 people to test audiotex/videotex-based parataxi services for both commuter and E&H transportation services. Regulation NV-type ordinances are also in the process of being. implemented throughout San Diego, which will provide incentives for employer participation in operation tests of innovative concepts.

4. Roseville - This rapidly growing residential and employment center is located 20 miles northeast of Sacramento on I-SO. Major employers include Hewlett Packard (HP), Southern Pacific, Roseville Community Hospital, NEC Electronics and Roseville Telephone. The City of Roseville currently has a population of 42,000. However, this is expected to more than double within the next 20 years. If HP or the Sacramento Bee (which provides general-purpose audiotex services throughout the Sacramento metropolitan area) become interested in CST or

other IVHS programs, Roseville would be an excellent site to test audiotex/videotex-based strategies for dealing with travel between the suburbs and the central city (i.e. Sacramento) as well as intra-suburb travel. A TMA was established in Roseville in 1990-1991 and traffic mitigation ordinances are now being implemented. Roseville also has a small bus fleet which could economically be converted to . "smart" buses.

5. Simi Vallev - This community is located 40 miles northwest of Los Angeles in Southeast Ventura County and is adjacent to the Western perimeter of the San Fernando Valley. It currently has a population of approximately 100,000 and has a small fixed-route minibus system and a dial-a-ride system. Major employers include the Simi Valley Unified School District, Farmers Insurance, First Interstate Bancard, Simi Valley Adventist Hospital, Micom Systems, Whittaker Electronic Systems and Wambold Furniture. Simi Valley also has an extensive vanpool program to transport residents to the San Fernando Valley and to Los Angeles.' A TMA was organized in 1990. Because of both its isolation and growing traffic congestion problems on Highway 118, Simi Valley would be an excellent site to test the capabilities of an audiotex/ videotex-based ATIS to integrate transit, paratransit and ridesharing services in a medium-sized urbanized area.

California has many other urban, suburban and rural communities that would be excellent sites for operational testing of, CST, ATIS, ARTS, and other Intelligent Vehicle-Highway Systems (IVHS) concepts.

Transportation researchers have pointed out for years that many of America's transportation problems and transportation-related energy and environmental problems are not caused by a shortage of resources. America has enough buses, vans and automobiles to carry everyone in the country at the same time using only the front seats of the automobiles. We also have enough road space for all of them to travel at the same time with little or no traffic congestion. Our problem is that we are not using this capacity very well. Recent developments in computers, telecommunications and IVHS concepts offer great promise in providing new tools to manage our transportation resources in a much more cost-effective manner in the -future.

The following sections discuss each of the ten tasks involved in the analysis of\single-trip carpool (aka parataxi) services, the preliminary design of an audiotex/videotex-based California Smart Traveler (CST) System and the preliminary evaluation of possible sites for operational testing of CST systems.

Task 1 - Develop A Model for Estimating the Supply of Parataxi Vehicles During Peak Commuting Hours

A U.S. Department of Energy (USDOE) report, "Vanpool *Options* and Energy Savings Potential** (l), contains the following results of a survey of commuter drivers to determine how their interest in providing carpool/vanpool rides would increase with increased monthly compensation levels.

Table 1

Additional Income As An Incentive For Adding Ridesharing Drivers

Additional Income Per Month ($1978)	Additional Income Per Month ($1991)[1]	Per Mile ($1991)[2]	Percent of Drivers Interested in Adding Riders: Very Interested	Percent of Drivers Interested in Adding Riders: Interested[3]
0	0	0	123	35%
$25	$51	.12	252	49%
$50	$102	.23	352	61%

It is assumed that the supply of parataxi (i.e., single-trip carpool) drivers would be at least as high as conventional vanpool drivers for each compensation level because parataxi services are less restrictive for drivers. For example,a single-trip carpool driver can choose to leave at any time or can choose not to offer parataxi services at any time on any day. It should be understood that only carefully-screened riders will be allowed to take parataxi rides and only carefully-screened *drivers* will be allowed to offer parataxi rides, The data in Table 3, which are plotted in Figure 1, show that driver interest in providing rides increases linearly with income or "fares" per mile. This linear relationship (model) can be described by the following equations:

[1] This column was derived from the USDOE data, based on a GNP Deflator of 2.03 between 1978 dollars and 1991 dollars.

[2] This column was derived from the monthly data, based on an average of 11 miles per one-way commute trip, 20 workdays per month.

[3] Interested equals sum of "very interested" plus "somewhat interested"in the USDOE survey.

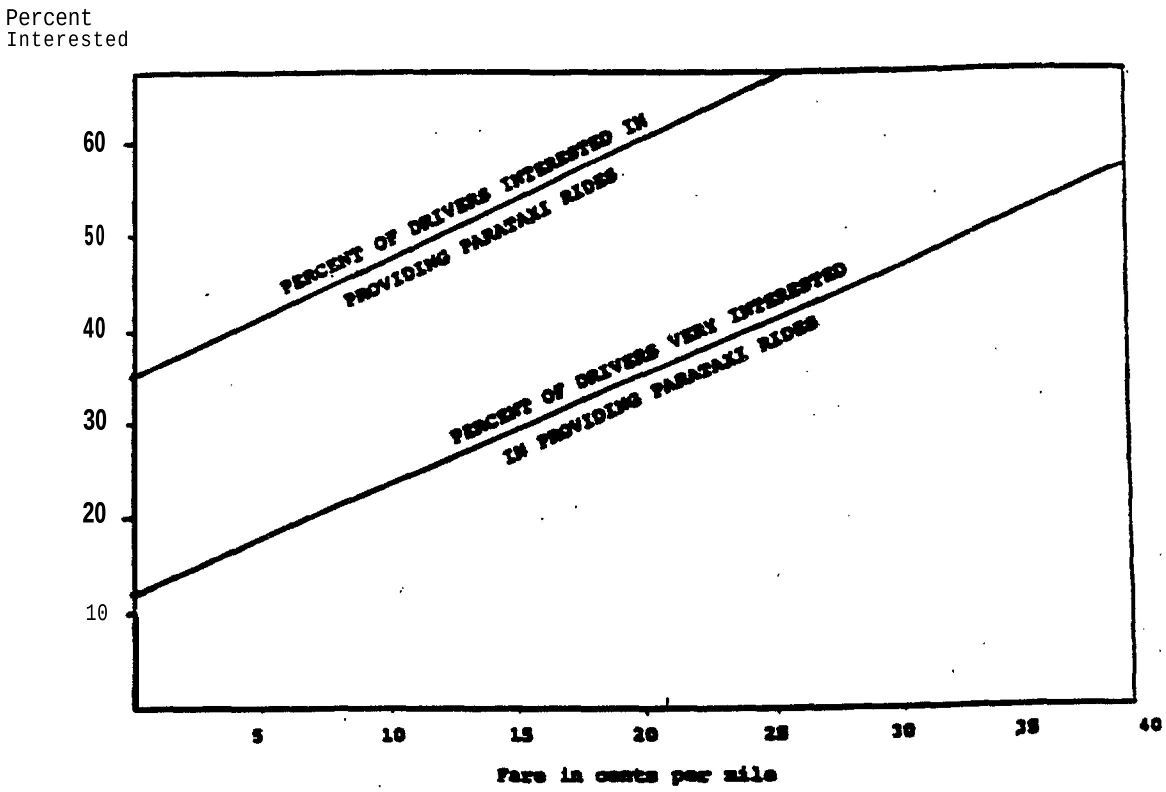
$$\text{Equation 1A: } \left[\begin{array}{l}\text{Percent of Drivers}\\ \underline{\text{Very}}\text{ Interested in}\\ \text{Providing Rides}\end{array}\right] = 110 \times \left[\begin{array}{l}\text{Income (Fare)}\\ \text{Per Mile}\\ (\$1991)\end{array}\right] + 12$$

$$\text{Equation 1B: } \left[\begin{array}{l}\text{Percent of Drivers}\\ \text{Interested in}\\ \text{Providing Rides}\end{array}\right] = 115 \times \left[\begin{array}{l}\text{Income (Fare)}\\ \text{Per Mile}\\ (\$1991)\end{array}\right] + 35$$

The first equation (1A) represents the most conservative (i.e. worst case) estimates for the supply of vanpool/parataxi drivers

FIGURE 1

DRIVER'S INTEREST IN PROVIDING PARATAXI SERVICES
BY FARE PER MILE (1991 DOLLARS)



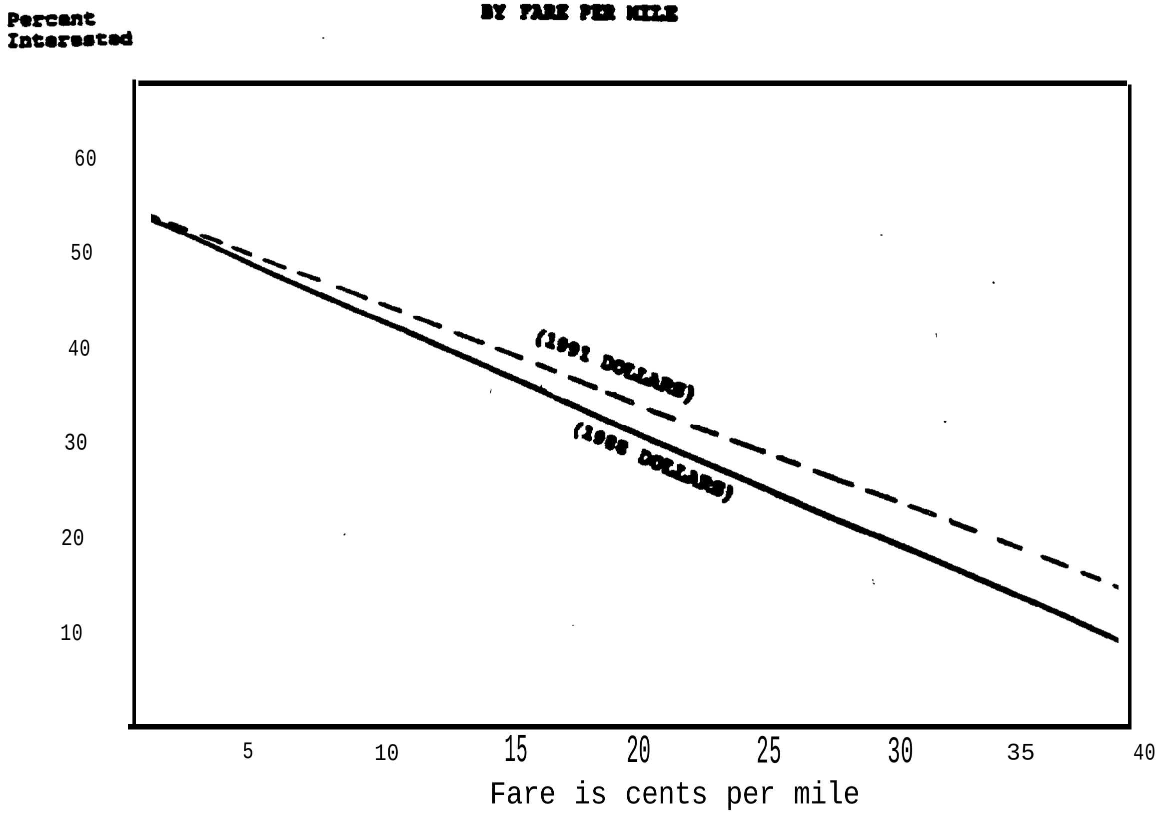
and the second equation (1B) represents the **most** optimistic (i.e. best case) estimates for the supply of vanpool/parataxi drivers based on several compensation levels.

Task 2 - <u>Develop A Model for Estimating the Demand for Parataxi Services During Peak Commuting Hours</u>

The state of Hawaii has conducted surveys of commuters in two large Honolulu suburbs, Mililani and Hawaii Kai, to determine their interest at several fare levels in using paratransit services that provide guaranteed seating and door-to-door delivery. The results of these surveys are contained in References 2, 3 and 4. Appendix A contains a copy of Reference 4, "<u>predicting Demand for Alternative Transportation Services in Suburban Honolulu</u>. The data

FIGURE 2

COMMUTER'S INTEREST IN USING PARATAXI SERVICES, BY FARE PER MILE



are plotted in Figure 2 and show that there is also a linear relationship between "fares" and ridership in door-to-door parataxi services. The data show how much interest in using parataxi services declines as "fares" increase- This linear relationship (model) can be described by the following equations:

$$\textbf{Equation 2A:}\quad \begin{bmatrix}\text{Percent of Commuters}\\ \text{Interested in}\\ \text{Taking Rides}\end{bmatrix} = -120\ X \begin{bmatrix}\text{Income (Fare)}\\ \text{Per Mile} \quad + 54\\ \text{(\$1988)}\end{bmatrix}$$

Equation 2B: $$\left[\begin{array}{l}\text{Percent of Commuters}\\ \text{Interested in}\\ \text{Taking Rides}\end{array}\right] = -106 \times \left[\begin{array}{l}\text{Income (Fare}\\ \text{Per Mile} \quad + 54\\ \text{(\$1991)}\end{array}\right]$$

The first equation (2A) was derived from Figure 2. The second equation (2B) was derived by substituting 1991 dollars, which equal ,885 (1988 dollars), into the first equation.

Task 3 - Recommend Fare and Driver Compensation Rates

At what "fare" level (in 1991 dollars) is the percent of commuters interested in taking parataxi rides (Equation 2B) equal to the percent of commuters very interested in providing parataxi rides (Equation lA)? The intersection of these two equations occurs when:

$$-106\ (\text{FARE}) + 54 = 110\ (\text{FARE}) + 12$$
Fare = 20 cents (in 1991 dollars) per mile

At this fare level approximately 30 percent of the commuters would switch to parataxi services. This is the "worst case" scenario based on the USDOE and Hawaii data.

At what "fare" level (in 1991 dollars) is the percent of commuters interested in taking parataxi rides (Equation 2B) equal to the percent of commuters interested in providing parataxi rides (Equation lB)? The' intersection of these two equations occurs when:

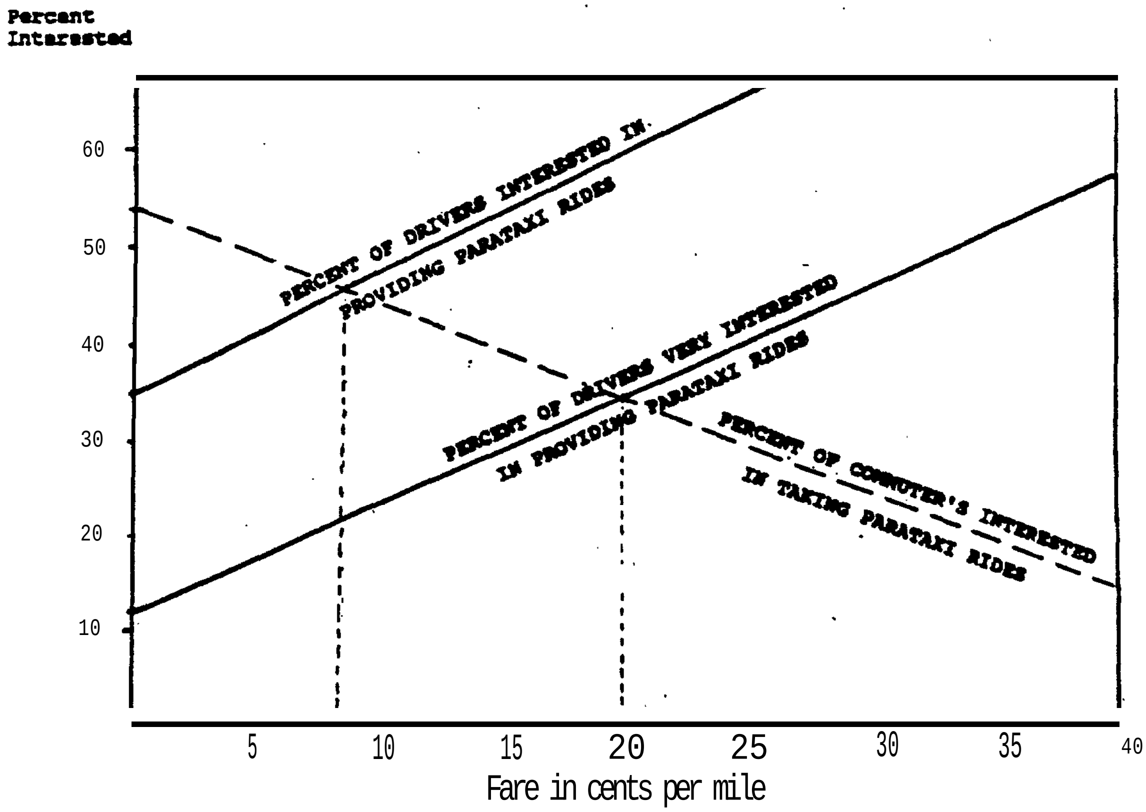
$$-106\ (\text{FARE}) + 54 = 115\ (\text{FARE}) + 35$$
Fare = 9 cents (in 1991 dollars) per mile

At this fare level approximately 45 percent of commuters would switch to parataxi service. This is the "best case" scenario based on the USDOE and Hawaii data.

These two intersection points are shown graphically in Figure 3. One subset of commuters that have been very difficult to attract out of their Single-Occupant Vehicles (SOVs) and into Multi-Occupant Vehicles (MOVS), are suburb-to-suburb commuters who live within 5 miles of *their workplace.* Table 2, which contains the results of a survey by the Bellevue (Washington) TWA, shows this. The reasons for this are straight-forward. The additional waiting and travel times associated with MOV travel would more than double the' time associated with SOV travel for these short commuting trips. As a result (see Figure 7), most short-distance, suburb-

FIGURE 3

COMMUTER'S INTEREST IN PROVIDING AND TAKING PARATAXI SERVICES BY FARE PER MILE (1991 DOLLARS)



to-suburb commuters find driving alone is more cost-effective than using MOV modes. On the other hand, these short-distance, suburb-to-suburb SOV commuters cause almost as much air pollution as longer distance SOV commuters because of the "cold-start" problem.

TABLE 2
Bellevue CBD Commuters, 1990 Survey
Mode split by residential location.

Residence		SOV	MODE POOL	BUS	**TOTAL**
Bellevue (<5 miles)	26%	88%	7%	5%	**100%**
Adjacent (5-10 miles)	42%	83%	10%	7%	**100%**
Seattle (5-10 miles)	17%	81%	8%	11%	**100%**
Farther (>10 miles)	15%	75%	20%	5%	**100%**
Total	100%				

Source: 1990 Bellevue CBD Transportation Mode Use Study, Gilmore Research (Ref. 5)

With current emissions control technologies,. approximately 90 percent of the emissions occur in the first mile of a seven mile trip. Emissions that occur when an automobile is first started and the catalytic converter is cold *are* referred to as "cold-start" emissions. Something needs to be done to reduce the use of SOVs for short distance, suburb-to-suburb trips by commuters within low-density areas, including trips between suburban residences and transit park-and-ride lots.

One way to increase short-distance parataxi ridership rates is to use distance-based fares. The City of Blois in France found that ridership, particularly short-distance ridership, increased when they installed a distance-based fare structure on their bus system in the mid-1980s. Surveys conducted after the distance-based fare system was installed in Blois, found that the relatively high costs per passenger mile kept many short-distance travelers from riding the bus when the flat-fare structure was in place. Passengers on the Blois bus system insert a "Smart" farecard into one or more readers on the bus when they enter and exit. The "Smart-Card" which is the same size as a VISA or American Express credit card: records the origin and destination points and the distance and fare in a microprocessor chip embedded in the plastic. Each passenger's account is automatically debited by the amount of the fare.

It should be noted that employees who live close to their work places will tend to have short waiting times for parataxi services. As the travel paths of co-workers and others who work in the same employment neighborhood (e.g., suburban office park) converge on a work site from residences around the region, the density of commuter vehicles heading for that work site increases. The low waiting times should. enable parataxis to attract many short-distance suburb-to-suburb coinmuters out of their single-occupant automobiles.

Similarly, special checkpoints could be established within a mile or two of most residences to give commuters and other travelers better access to parataxis for longer trips. If these special checkpoints were located near intersections of frequently-traveled roadways, for example, the travel paths of residential neighbors would tend to converge on these points and provide good parataxi feeder/distribution services for each neighborhood.

One way. to increase overall parataxi ridership rates would be to allow parataxi riders to "rent" the entire back seat of the parataxi vehicle for a single "fare". In addition to providing a taxi-like environment and room for shopping bags, this approach would effectively reduce the fares of each passenger by 50 percent in a two-passenger group and by 67 percent in a three-passenger group. This approach should-also help reduce security concerns among riders, since they will either be riding in the back seat by themselves or with one or two friends. The security issues will be discussed in more detail in a subsequent section.

For the first few demonstration projects, it is recommended that parataxi "fares" be set at sixty (60) cents for the first two (2) miles plus twenty (20) cents per mile thereafter for those who do not have monthly transit passes. Those who have monthly or longer-term transit passes would pay just twenty (20) cents per mile for parataxi services. Similarly, riders who transfer from one parataxi to another parataxi to complete their trip, would not need to pay sixty (60) cents for the first two (2) miles on the second or subsequent legs. They would just pay twenty (20) cents per mile for the distance they traveled on these legs,

The parataxi matching and dispatching subsystem of CST will compute the fares for each parataxi ride. Parataxi drivers will not need to install meters in their vehicles or calculate the distances and fares from their odometers. Parataxi riders will not need to worry about paying higher fares because their drivers took circuitous routes. Parataxi fares will not be collected by the driver. Instead, parataxi riders' accounts will be billed monthly, and parataxi drivers' accounts will be credited monthly for parataxi use. As with carpools, some people may serve as drivers one or two days a week and as riders on the other days. Their accounts would be billed/credited monthly for net parataxi use.

Under the proposed "fare" structure, a‘ parataxi rider without a transit pass and up to two friends would pay eighty (80) cents for a three (3) mile trip and two dollars and sixty cents ($2.60) for a twelve (12) mile trip. These should be attractive fares for on-call, door-to-door transportation services with guaranteed seating. Based on the market research surveys conducted in Honolulu, the availability of quality parataxi services in an area could eventually attract at least 20 percent of commuters who now live and work in the area out of their single-occupant vehicles. Based on USDOT Federal Highway Administration (FHWA) data, (Ref. 6), this could reduce traffic congestion delays, in large U.S. urbanized areas on the order of 50 percent.

For the first few projects, it is recommended that parataxi drivers receive all of the "fares" collected from their.parataxi riders. All of the other funds required to develop and operate the computerized parataxi dispatching system - including special insurance, backup taxi service, advertising and training - should be provided by the public and private organizations sponsoring the demonstration project. Under this approach, there would be no direct subsidies of parataxi drivers or riders. Average parataxi "fares" per mile should be slightly higher than those of carpools and vanpools whose users usually commit to a monthly payment. As a result, there should be no financial incentive for commuters who are now in carpools or vanpools to switch to parataxi services. It would be desirable, however, if local government and business organizations in the area provided community parataxi drivers with the same benefits (e.g., special parking places/rates) that they now provide to in-house carpool and vanpool drivers.

In order to provide a high level of parataxi services during the start up of the first demonstration project, it may also be desirable to reward those who offer to provide parataxi rides but for whom there are no riders. Based on the data collected in a USDOE survey (shown in Table 1 and Figure 1), 25 percent *to 49* percent of commuting drivers would be interested in finding riders if they could receive at least $51 per month for their efforts. It appears that an approach which would guarantee parataxi drivers at least $51 pr month (in 1991 dollars) if they would provide or offer to provide 40 parataxi rides during specified hours on at least 20 different days in a month, would accomplish this.

In order to provide a minimum level of parataxi services at all times, it would be desirable to contract with one or more local taxi companies to provide up to 5 percent, for example, of all "parataxi" rides. The CST system would use these contract taxis, which are available to go any place at any time within the area, as "wild cards" to handle trips that may be difficult to fill with parataxi services. These taxis, with on-board communications equipment, could also receive instructions on their trips to pick up additional shared-ride passengers. The taxis used in this "wild card" role would eventually be subsidized out 'of parataxi fares. The primary objective is to give privately-owned and privately-operated taxi companies a greater role in local public transportation systems and to maintain the revenue base of local taxi operators.

Task 4 - Recommend Security and Billing Subsystem

According to Dr. Martin Wachs of UCLA, one of the reasons for the decline of public transit ridership in the United States is the widespread fear of crime. In his words:

> "America's transit systems are physically dangerous because criminals prey on the traveling public at bus stops and subway stations, on buses, streetcars, and subway trains. In a survey of more than l100 transit users in Los Angeles, for example, 16% reported being victims of a crime, and another 19% had witnessed a crime at a bus stop, on a bus, or walking to or from a bus stop. The magnitude of transit crime is understated by crime reporting mechanisms. Uniform crime reporting-forms do not designate transit stations or vehicles as specific venues for recording crimes, and they are thus lumped together with many other crimes in a category called "street crimes" Despite inadequate data, it is widely understood by transit managers that some people choose to drive or simply decline to travel because transit environments frighten them.
>
> The modern subways in Washington, Atlanta, and Baltimore have been consciously designed as secure environments, and crime rates on these systems are remarkably low; they are among the safest places in those metropolitan areas. Far less attention to security has been given to the design of buses or the provision of lighting and police surveillance at bus stops.

In many urban areas transit authorities have reluctantly accepted responsibility for policing the vehicles and added uniformed police to their payrolls. On the other hand, security at bus stops has become a political football. Transit officials claim that it is the responsibility of the local police,; local police refuse to allocate special resources to the protection of transit installations. National transit policy is virtually silent with respect to the importance of protecting the riding public, and those who have a choice increasingly avoid transit, leaving those who have no choice but to ride even more vulnerable to urban criminals." (10)

In order to be successful, parataxi systems must be safe and must be perceived by the public to be safe. The use of door-to-door services and random (or at least unscheduled) vehicle arrival times will make parataxi riders a more difficult target for criminals. The availability of audiotex-/videotex-based Advanced Traveler Information System (ATIS), with better information on transit vehicle departure times, will also help reduce waiting times at bus and rail stations.

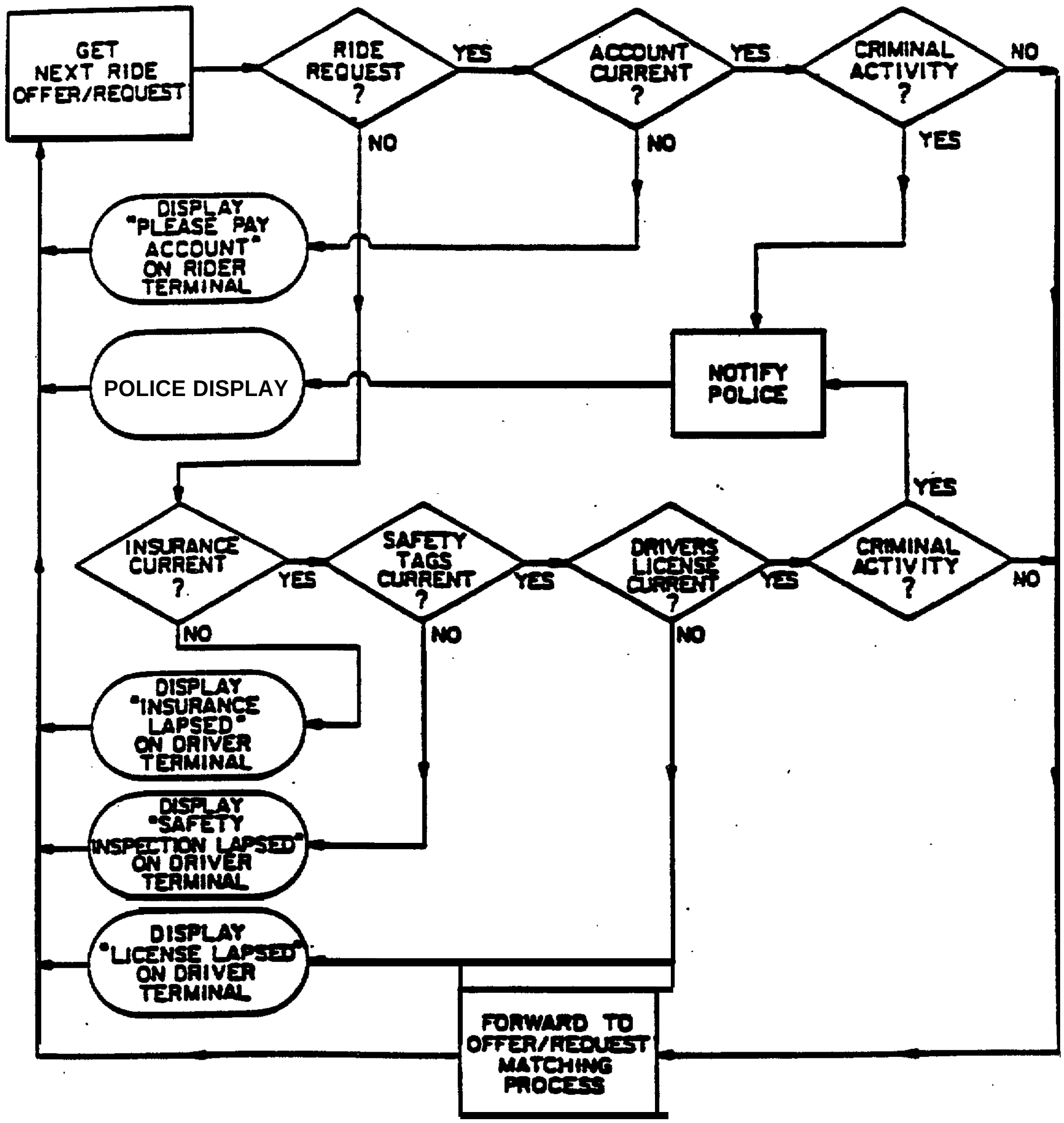
The recommended security system for the first demonstration of a parataxi system, which will be based, on standard touch-tone telephone equipment, is described in Figure 4 and in the discussion of Task 8. Only people that have a CST identification card, account number and a Personal Identification Number (PIN) will be eligible to request or offer parataxi rides. A detailed audit trail will be made of all parataxi ride offers and ride requests, including the caller's telephone number. An extensive analysis will be made of all transactions with invalid PINs or vehicle codes. These features should make it the safest or one of the safest public transportation services in the United States. For the first demonstration project, moreover, it is recommended that all drivers and riders be members of a closed-user group (e.g. a government agency, a major employer, a university's faculty, staff and students). It is also recommended that at least one of the endpoints of each parataxi ride offer be the driver's residence or the driver's place of work/school. In addition, at least one of the endpoints of each parataxi ride request be the rider's residence or the rider's place of work/school.

Figure 4 shows that both parataxi drivers and riders will' be checked prior to each match for "criminal activity". If either is wanted by the police, for example, the police would be notified so that they can handle the ride offer or request. The security flowchart in Figure 4 could also be modified to check vehicles for current air quality compliance certificates or almost any other characteristic. It is important that the security procedures be carefully reviewed by government, business and community leaders and potential parataxi drivers and riders in the proposed test sites and,adapted to meet their needs.

FIGURE 4

PROPOSED DRIVER AND RIDER SECURITY PROCEDURES

FOR AN AUDIOTEX-BASED PARATAXI DISPATCHING SYSTEM



The security features outlined for a videotex-based parataxi system would be almost exactly the same as *for* an audiotex-based system. New technologies (e.g. smart-card telephones, voice-print identification) are expected to increase the security features of telecommunications and parataxi systems in the future. However, the private account number and personal identification number (PIN) procedure -which is now used by state unemployment agencies, stock brokerage firms and other organizations *for* a variety of high dollar value transactions - provides a relatively high level of security for a low cost.

The billing system for the CST/parataxi system, based *on* either audiotex or videotex technologies, is proposed' to be a monthly statement, similar to those now issued by VISA and other credit cards. No cash transactions will be involved for parataxi services. Parataxi drivers will not be required to make change and parataxi riders will not be required to use exact change. For the first few demonstration projects, it is recommended that the billings and collections be handled by an existing bank, credit card company, etc. to minimize development time, front-end costs and operational problems. Payments for parataxi services would be debited from the rider's credit card account and credited to the driver's credit card account. This would also minimize postage, labor, supplies, etc. It is similar to the approach now being used by some automatic toll collection systems (e.g., Dallas Tollway) and by some videotex (e.g., COMPUSERV) services.

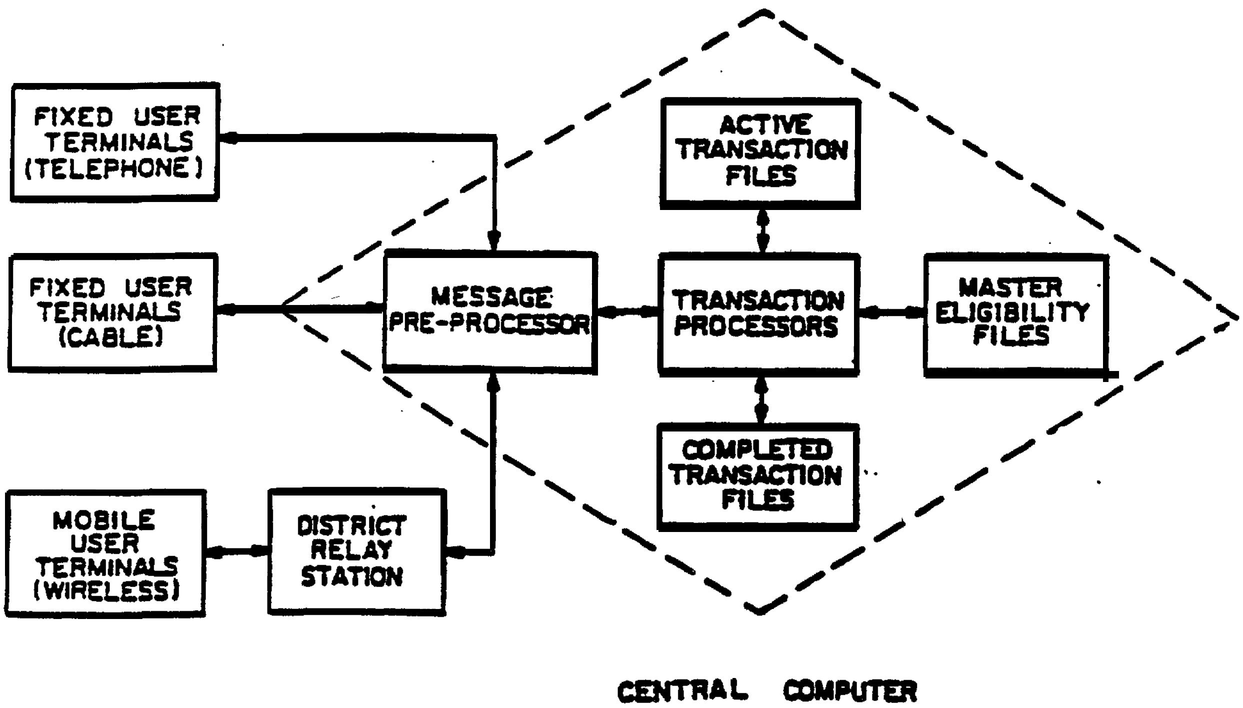
Task 5 - Preliminary Design of Parataxi Dispatching System

The California Smart Traveler (CST) System should be designed to facilitate changes that will be required in the future. The use of UNIX, SQL, C and other "open architecture" approaches in developing CST will give Caltrans and other users the ability to choose from a variety of hardware, software and service suppliers. It should also save time and money in interfacing CST with other systems, such as a Traffic Operations System (TOS) or E-911 system, in order to exchange information and avoid duplication of efforts. Traffic Operation Centers (TOCs), in particular, require access to timely and accurate data about local and regional accidents, weather, construction projects, road conditions, etc. CST designers should make maximum use of this multi-modal information source.

In addition to being multi-modal from a transportation standpoint, both the parataxi dispatching subsystem and CST should be designed to be multi-modal as far as input device, output device and transmission mode are concerned. Because of user familiarity and the widespread availability of .tduch-tone telephones, these low-cost, user-friendly devices should be the foundation of CST projects. In addition to this audiotex-based foundation, one of the early tests should also allow people who have personal computers (PCs) with modems to use them to access CST.

One advantage to using a PC or videotex terminal rather than a telephone is that one has more time to write down information. In fact, no writing of information by parataxi riders *or* drivers would be required if the PC or videotex terminal is equipped with a printer. A second advantage to using a PC or videotex terminal is that errors are reduced. As soon as an origin or destination

FIGURE 5
CST OVERVIEW



checkpoint code is entered, for example, the terminals screen would display the complete address. This capability would give the user a much better chance to detect input errors. In addition, the ability to print output from CST computer system, rather than having to write it down, would help the user avoid making errors in transcribing output information.

In the future, videotex systems are expected to make much greater use of touch-screens to make access to information more user-friendly. Instead of using a keyboard to enter checkpoint numbers of a.theatre, restaurant, etc., a user requesting a parataxi ride could simply touch a map on the videotex system, which'would then display a picture of the theatre (including the name and starting time of the films) or the restaurant (including the menu and today's specials). One videotex service in France already allows a user to electronically "window shop" at all the stores on major city streets.

Figure 5 provides an overview of the proposed system. The three boxes on the left indicate the three general types of input/output devices. These include:

1. Fixed terminals (telephone line data transmission). These devices include touch-tone telephones, videotex terminals and PCs, as previously discussed. They also include fax machines, new picture-phones (which may also be equipped with a printer), video games (e.g., Nintendo

games are being used for home banking in Japan and lottery games in Minnesota), and even rotary phones if CST is equipped with voice input capabilities. Local telephone companies are now in the process of replacing copper wire lines with fiber optic lines. This will greatly increase the information carrying capacity of the telephone network and will permit the installation of a wide variety of new, multi-media information terminals in public kiosks and in private homes, offices and shops. Local telephone companies are also.using new technologies to increase the capacity of existing copper wire lines. New semiconductor chips and new data compression algorithms will soon permit the transmission of full-motion, color TV over existing copper wire lines. CST should be designed to take advantage of these new developments in the telephone industry.

2. Fixed terminals (TV cable and other non-telephone line data transmission). A variety of new interactive information services are being planned or implemented using cable TV as the transmission medium. Some of these will offer many of the same capabilities as telephone-based videotex services, including home&shopping, tele-, banking, electronic mail. Some of the input devices will have a keyboard similar to a PC, *Others* will have input devices that look more like a video game controller or a remote TV control unit. Still others will feature voice-activated or touch-screen input. Just as the telephone companies are seeking to broaden their markets by offering new information services (e.g., audiotex, videotex, pay TV), cable TV companies are seeking to use their communications networks to carry voice, data and new information services (e.g., interactive training, videotex, teleconferencing). The FCC appears to be encouraging cable TV companies to do this in order to provide the public with a second source for local telecommunications services. CST should also be designed to take advantage of these new developments in order to realize any price-performance improvements that they provide.

3. Mobile terminals (radio and other wireless data transmission). A variety of new wireless devices, including cellular phones, digital radio terminals; fax machines, computers and new pocket-sized Personal Communications Network (PCN) units, are now being developed and tested in the United States, Japan, and Europe. They will provide users with greater flexibility and security. Some of the new PCN "telephones", which are being designed to replace pay phones and to reduce the cost of cellular phones, even have "smart-card" readers in them for identification and billing purposes.

Instead of associating a telephone number with a physical location (e.g., phone booth, desk, home), a telephone number will be associated with an individual in the future, wherever he or she may be. More and more tethered communications devices (e.g., telephones, computers with telephone modems) will be replaced with wireless communications devices (e.g., PCN "phones", laptop and notebook computers equipped with radio-telephone modems). CST should be designed to take advantage of these new capabilities when they become available.

The reduced cost and availability of mobile terminals will permit major improvements to future parataxi systems. Instead of only transmitting ride requests to parataxi drivers before they start their trips, these requests can also, be transmitted to drivers during their trips. This would tend to reduce waiting times for riders and increase average vehicle occupancy (AVO) rates and revenues for parataxi drivers. The availability of mobile terminals will also permit Traffic Operations Centers (TOCs) to advise parataxi drivers of problems along their planned routes and to recommend alternative paths. In turn, parataxi's will be able to serve as traffic probes for TOCs.

The price of computers and telecommunications equipment is expected-to continue to decline and the performance of these electronic devices is expected to continue to improve during the next few decades. An "open architecture" design approach for CST will provide the capability to add a variety of new hardware and software components in the future. This approach will also let the user rather than the system designer decide what device and what transmission medium he or she finds most cost-effective.

Appendices B and C describe the procedures that one would use to retrieve information from audiotex and videotex systems respectively. These technologies should not be considered to be design alternatives but user alternatives. Both capabilities will be needed in CST, particularly under the new Americans with Disabilities Act (ADA) requirements. An audiotex-based system, for example, would be inadequate for a hearing-impaired person. A videotex-based system would be inadequate for a visually-impaired person.

Each test site should have a CST operations center that contains a number of "HELP" desks with telephone and computer terminals. Personnel at a HELP desk should be available to assist audiotex or videotex "callers" with their inquiries in the event of problems. The design *of* the center could be very similar to a *9-l-l* dispatching center, an airline reservations center, or a computer-managed taxi dispatching room. It will also be possible for HELP-desk operators to work from satellite offices or their own homes. This could be an excellent job for those who prefer to work at home for medical *or* other reasons.

One HELP Operator in Germany can now handle at least 15,000 residents during off-peak hours and at least 10,000 residents during peak commuting hours even though Germany has higher transit ridership rates than the United States. *Moreover,* the German systems use HELP-desk operators to enter Origin, destination and other trip information into the public transportation information system. This is a labor-intensive process that could be streamlined by letting users enter their own trip information via touch-tone telephones (i.e., audiotex) and user-friendly computer terminals [i.e., videotex). By using these do-it-yourself approaches in CST, communities in the U.S. should be able to handle at least 45,000 residents during off-peak hours and at least 30,000 residents during peak hours with each HELP-desk operator.

It should be noted that in German communities which have already installed transit command and control. systems, almost two&thirds (67%) of all public transportation trips are prescheduled and do not use HELP-desk operators to enter trip information. This pattern should also apply to systems in the United States, where almost half of all transit trips are for travel to and from work. It should also be noted that additional HELP-desk operators will be required for training and special assistance during the first few months of the implementation of a new CST system. This peak load implementation/training workforce could be handled in a cost-effective manner by college students on their summer vacations. These temporary workers would require modest hourly wages and few fringe benefits. Most would welcome the opportunity to work on a project that could improve the quality of life in their communities.

Task 6 - Cost-Benefit Analyses

The primary objective for installing *CST* and other Intelligent Vehicle-Highway Systems (IVHS) applications in an area is to increase the productivity of available transportation resources and to reduce traffic congestion, gasoline consumption, air pollution and mobility problems in a cost-effective manner. One way to measure the effectiveness of these systems would be to measure what happens to the number of vehicle trips per capita, vehicle miles per capita and vehicle ownership per capita in the service area after these IVHS applications are installed. One way to measure the costs of these systems would be to measure what happens to the total costs, both direct and indirect, per passenger trip and per passenger mile after these IVHS applications are installed.

Figure 6

A Typical CST Public Transportation

Ride Request

The following sections outline how users will request a public transportation ride, including door-to-door, parataxi services and route-deviation services, using the California Smart Traveler (CST) System:

A. Using a conventional touch-tone phone:

1. Dial the CST number.
2. Enter CST account number.
3. Enter four-digit Personal Identification Number (PIN), which will serve as an "electronic signature".
4. Enter a personal trip code (e.g., "W" means I would like a ride from home to work, as soon as possible. I am traveling alone and have no wheelchair or other special equipment.)
5. The CST system will dispatch a transit, paratransit or ridesharing vehicle and advise the passenger .of the details.

B. Usine a "smart" touch-tone phone:

1. Enter "CST". The autodialer will enter the phone number and the CST account code.
2. Enter a four-digit PIN
3. Enter a personal trip code
4. The CST System will dispatch a vehicle and advise the passenger of the details.

C. Using a "very smart touch-tone phone:

1. Say "Home, Jane" or "Home, James". The phone will analyze the voice print and, if satisfactory, enter the phone number, CST account code, four-digit PIN and personal trip code.

Telephones may either be conventional models or wireless models. Within the decade, it is anticipated that vest pocket-sized Personal Communications Network (PCN) models will be available at attractive prices. These PCN phones will be wireless and will include a smart-card for security and billing purposes. Marketing trials of these PCN units are already underway in Europe. Similar trials are expected to begin in the U.S. within the year.

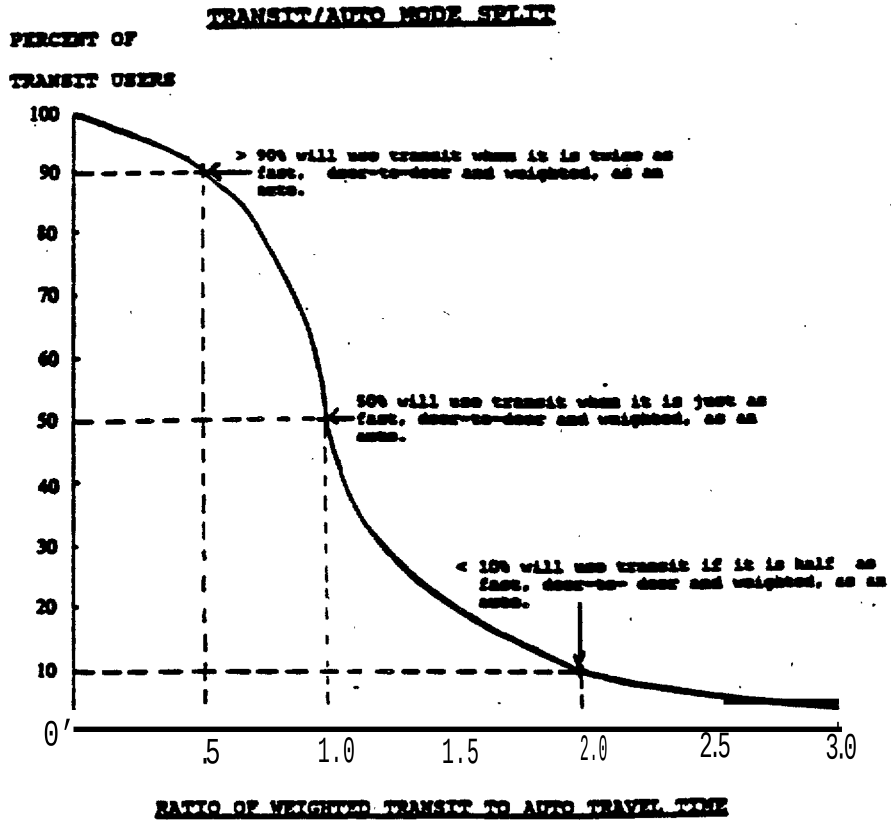
In order to minimize costs to both users and taxpayers, CST will be designed to make maximum use of conventional carpools/vanpools and single-trip carpools/vanpools (i.e. parataxis) to improve public transportation services. The market research studies by USDOE and the State of Hawaii indicate that adding a CST-based parataxi system to an area should eventually take 20 percent or more single-occupant commuter vehicles off the road during peak commuting hours. Is this a reasonable expectation? The following analyses of the Bay Area Rapid Transit (BART) system by Harvard Professors Dr. John Meyer and Dr. Jose Gomez-Ibanez (8) suggest that it is reasonable, at least after some period of time, since parataxis and sov commuter vehicles would have approximately equal door-to-door travel times:

> "In the BART service area, worktrips to the major employment centers, on average, take about 40 minutes on BART. The bus transit that BART supplanted served such trips, on average, in about 54 minutes. Thus, BART effectuated a 14-minute average improvementpertrip over previously available public transit. But automobile trips to these same employment centers average about 26 minutes during peak periods so that commuting by automobile is faster than BART by a fairly substantial margin.

A typical "modal split" curve, shown in Figure 7, illustrates how such changes in travel time might influence the choice

FIGURE 7

TRANSIT/AUTO MODE SPLIT



between public transit and the private automobile in San Francisco. A modal split curve is often used by transportation' planners to summarize estimates, of the relationship between the shares of travelers carried by transit and auto and the relative travel times or costs of the two modes. Modal split curves typically have the shape shown in Figure 7. In essence, BART moved the average ratio of transit to automobile travel times in San Francisco from 2.15 (56 minutes divided by 26) to 1.54 (40 minutes divided by 26). Since such a change is located on the right-hand flat section of the curve in Figure 7, BART should have little impact on the modes used by San Francisco travelers. If the change in travel times brought about by BART is not sufficient to affect travelers' choices of mode, it is also unlikely to be sufficient to affect the choices of residential or business location, especially in the short run.

These travel-time figures are overall averages, though; which may disguise a great deal of diversity and change in particular areas. For example, if BART created several areas (perhaps around important transit stations) where the transit-to-automobile time ratio moved close to unity, choice of mode and land usage could well change. The potential number of areas with such favorable transit-time ratios would be greater if the overall reduction in the average transit-to-automobile time ratio had been more dramatic, For example, if BART had brought the overall transit-to-automobile time ratio down to 1.00 rather than 1.54. transit would likely have been preferred to the automobile for commuter worktrips in large sectors of the BART service area".

CST should be able to provide taxi/parataxi services that have transit-to-automobile time ratios close to 1.00 for commuter trips in many areas. CST should also improve the weighted door-to-door travel times of conventional transit services in the area by providing improved feeder services to bus and rail stations.

Transportation researchers (11, 12) have-found that the ratio of transit travel time to auto travel time (Fig. 7) should be weighed as follows:

1. Time spent outside transit vehicles (i.e. walking, waiting, transferring) should be weighted at least three (3) times as much as time spent in a transit vehicle or auto, in computing weighted door-to-door travel times.

2. If out-of-pocket auto costs (i.e. excluding depreciation, insurance) per passenger mile are different than transit fares per passenger mile, travel times should be adjusted. One way to do this is to add additional time

to either autos or transit vehicles to compensate for the additional out-of-pocket costs. For example, one could weight each additional dollar of costs per trip by five (5) to ten (10) minutes of in-vehicle travel time. Figure 7 shows how this would affect market share.

Figure 7 suggests that 50 percent of all commuters would use automobiles and 50 percent would use public transportation if their weighed door-to-door travel times were equal. If the costs of automobile use increased because of higher gasoline costs, higher tolls, higher parking fees, etc., than the weighted door-to-door travel times of the automobile would increase relative to transit and a greater percentage of commuters would use transit. On the other hand, if the weighted door-to-door travel times of transit modes increased because of higher fares or less frequent service, than a greater percentage of commuters would use automobiles.

One might get the impression from the quotation on pages 20 and 21 that Dr. Meyer and Dr. Gomez-Ibanez consider the automobile and transit to be mutually exclusive. This is not the case. Their book "Autos, Transit and cities" (8) encourages greater use of automobile-based public transportation modes (e.g., shared-ride taxis, jitneys, carpools) in order to improve transit service and reduce costs, particularly in low-density suburban areas. This approach is consistent with current USDOT and FTA policy. In fact, shortly after Brian Clymer became UMTA (now FHA) Administrator, he suggested that we redefine public or mass transit in the U.S. to include all modes other than the single-occupant automobile.

A number of, prominent transportation researchers (8, 10, 11, 13, 14) have been very critical of the high levels of spending on new rail transit systems in the United States since 1975. These researchers believe that most of the rail money could have been better spent improving bus, paratransit or ridesharing services, since these modes are more cost-effective than rail in low-density suburban communities, where most metropolitan area residents now live and work. One of these researchers, Dr. Melvin Webber of UC-Berkely, has been an especially strong advocate for increasing the role of the private automobile in urban public transportation systems. In Dr. Webber's words:

> ....."A lot has been written about.the American's peculiar love-affair with the automobile, as though it were mere affection or fascination that has led to the dominance of private cars over all other modes of urban transport. But the auto is certainly not an American phenomenon. It is as popular elsewhere in the world as it is here. Whether in the highly developed nations of Europe or the least-developed nations of Africa and Asia, people who can afford cars buy them and use them, seemingly with more emotional passion than

Americans do, but probably for the same reasons, nevertheless. Autos are popular because they offer better transport service in some urban situations than do other modes. The key to the auto's popularity is its capacity to furnish door-to-door, no-wait, no-transfer service. In competition with other transport modes in low-density places, it usually wins hands down -- mostly because travel time from origin to destination is typically shorter than via other modes and because money costs, although not low, are tolerable.

Travel-times are short because a car that is available for an individual's exclusive use sits patiently waiting outside his door and is immediately accessible -- always on call, as it were. Where parking is available at <u>both</u> ends of a trip, as is common in low-density cities in the U.S., the car promises door-to-door accessibility. Where traffic flows freely, it promises a high level of mobility. Money costs are tolerable because the use of automobiles is subsidized. U.S. motorists are charged a modest gas-tax fee to cover some costs of road-building, while the heavy costs of congestion and of air and noise pollution are not directly charged to the motorists who generate them. It is scarcely any wonder, given the car's inherent advantages and the imposition of some of its operating costs on others, that it has become the preferred mode of transport for so many. It seems to be as popular in places like Mexico City where mass auto use has generated levels of congestion and air and noise pollution that 19th century Pittsburgh residents would regard as intolerable.

Of course, there are still a great many for whom discretionary use of a car is at best a dream. About a third of the U.S. population is not licensed to drive, most of them because they are physically incapable of doing so -- they are either too young, too old, or too handicapped; perhaps a fourth of them are simply too poor to own cars, even though auto-use is underpriced. In any case, only two-thirds of Americans are now able to drive; but not all of them have full discretionary use of cars. About half of U.S. families still have only one car that all members of the family must share. So, even though automobiles are dominant over all available personal transport modes, we are a long way from full and free auto-mobility for everyone. That, I suggest, is the paramount transportation problem we confront in the new metropolitan areas of the U.S. west.

You may argue that things are bad enough already. We now have more than one car for every two persons. If the numbers were to approach one for every person, we, like the folks in Mexico, City, would be scarcely able to move on the most-congested routes, much less enjoy free mobility. And, of course, you're probably right. So the problem must then be redefined to call for the design of a successor to the currently dominant private-automobile/public highway system. We need a transport system that would permit virtually everyone to enjoy the equivalent of automobile mobility, although not exclusively with the present arrangement of privately owned cars, each exclusively dedicated to carrying its owner in privacy........

. . . . .Western cities and the extensive suburban areas surrounding the older eastern cities are marked by low densities and by dispersed patterns of residences and work places. Few commuters originating in any single residential neighborhood are likely to be bound for the same work site at precisely the same time. So it is important that an alternative mass urban transport system be capable of serving small numbers of persons having the same combinations of origins, destinations, and schedules. It has to-be capable of collecting them virtually at their doors, on time, and then transporting them from wherever they are directly to wherever they want to go. That is to say, it must be capable of providing random access, just the way the telephone network connects everywhere to everywhere -- directly, and on demand.

Those are the very attributes that make automobiles attractive. They must also become the attributes of public transit systems. If public transit is to compete with private cars, it must do so on the car's own terms. That means, among other things, that future public transit must employ small vehicles that are able to carry those small 'groups of travelers who share the same combinations of origins, destinations, and schedules. The widespread dispersion of residences and work places since World War II has made large-vehicle (rail transit) systems obsolescent on all but a few routes within most American metropolises. The new modules are the 50-passenger bus, the 12-passenger van, and the 4-passenger motor car used as a public transit vehicle. The era of the suburbari railroad and the l0-car subway train is long since past for most of America, certainly for the American west and the new American south........

. . . . .Some cities here and abroad have experimented with incentives aimed at increasing numbers of passengers per car, and their publics have responded quite as expected. Commuters using the San Francisco Bay Bridge are collecting extra passengers from bus stops and BART stations because carpools are rewarded with speedy passage through the toll booths and a saving of at least 10 minutes and the 75-cent toll. It seems it does not take much saving in travel time or money cost to induce motorists to share their cars with others, even strangers -- so long as the arrangements are flexible and so long as the individual driver's freedom is not unduly constrained.

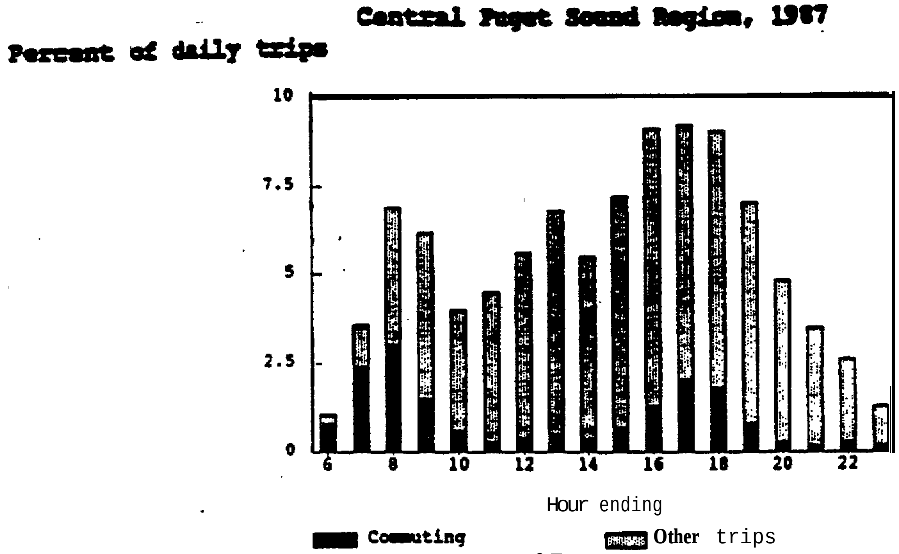
Prospects are promising for an urban transportation system that combines private use of private automobiles with public use of public automobiles and other shared vehicles that use streets and freeways. Exclusive use *of* selected streets for carpools, express buses, and group taxis can greatly inorease travel speeds, thus making these multiple-occupant vehicles the most-rapid components of urban transport systems. Because overall door-to-door travel time is probably the most important factor affecting a commuter's choice of travel mode, there may be no more effective way of reducing congestion and increasing urban mobility than through preferential treatment *for* multiple-occupant vehicles."......(ll)..

In addition to advocating a greater role for private automobiles in public transportation systems, Dr. Webber outlined the importance of both preferential treatment for multiple-occupant vehicles (e.g., HOV lanes, HOV tolls, HOV parking) and direct and indirect subsidies (e.g., traffic congestion delays, air and noise pollution, uninsured accident and health costs) for single-occupant automobiles. It appears that federal, state and local governments and private transportation organizations (e.g.., IVHS-America) are now moving toward a "carrot-and-stick" approach to reducing traffic congestion and related-problems. More leaders in California are supporting greater incentives for using multiple-occupant vehicles and lower incentives/subsidies for using single-occupant vehicles, particularly during morning and evening commuting hours.

There is a danger, however, in concentrating one's traffic reduction efforts on home-to-work commuter automobiles. Figure 8, for example, shows that only 44 percent of vehicle trips in the AM peak and only 24 percent of vehicle trips in the PM peak are made by home-to-work commuting autos, vans and trucks in the Puget Sound Area (Ref. 5) The rest are made for shopping, recreation and other purposes.

FIGURE 8

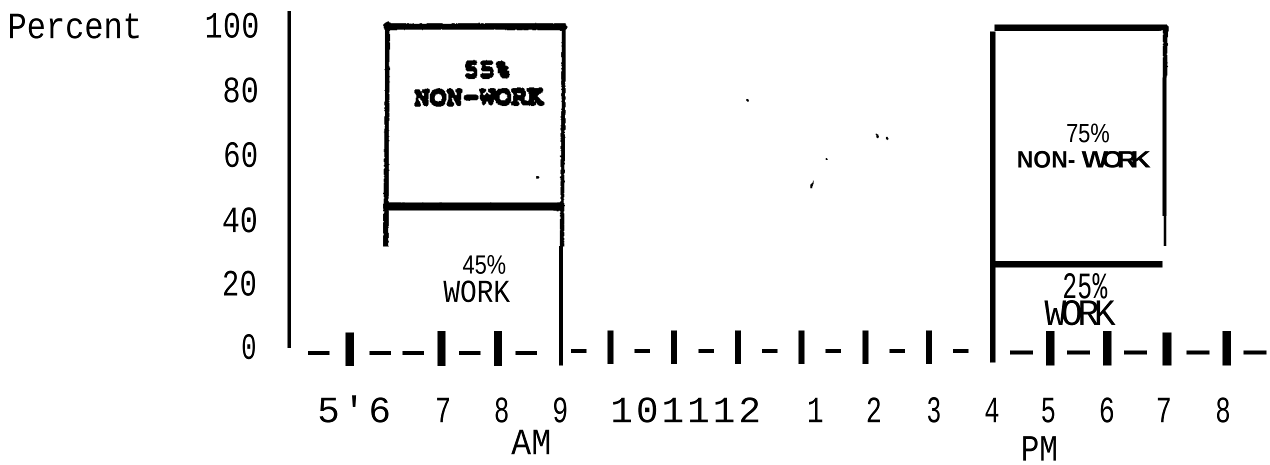
Weekday Person-Trips by Time of Day
Central Puget Sound Region, 1987



Removing half of the home-to-work commuting vehicles from the road during the PM peak, would only reduce the total number of vehicle trips 12 percent. Figure 9,which was derived from national survey data (Ref. 9) shows results similar to Figure 8.

Both Regulation XV and most traffic mitigation ordinances place most of the responsibility of solving California's urban traffic congestion and air pollution problems on local businesses. Based on the data shown in Figures 8 and 9, this appears inequitable.

FIGURE 9
WORK COMMUTERS SHARE OF VEHICLE TRIPS
DURING PEAK AM AND PM PERIODS



Furthermore, if the costs on employers gets too high it could not only reduce the growth of new businesses in California, it could also cause some existing businesses to leave. It would be desirable, therefore, to design and develop CST so that it could handle both work and non-work trips in an area.

Based on the costs of several multi-purpose videotex services it appears that an audiotex/videotex-based CST could be operated for approximately $3 per month per'capita or approximately $6 per month per employee. For a community involving 20,000 employees and 20,000 other residents, therefore, a CST center - including. telephones, computers, office space, personnel, etc. - would cost on the order of $1.44 million per year. If each worker and non-worker generates 2.5 one-way vehicle trips per day per capita, there would be 100,000 one-way vehicle trips per day. If 20 percent (i.e. 20,000) of these trips are taken by taxi/parataxi services each day and parataxis carry 95 percent (i.e. 19,000 trips each day), taxis would carry the remaining 5 percent (i.e. 1,000 trips per day). If the average taxi/parataxi trip is 4 miles, the. average parataxi fare would be $1 per trip and the average taxi fare would be $5 per trip. To have the taxi-backup services charge the same rate as the parataxis, therefore, would require a subsidy of $4 per taxi trip, or $4,000 per day, or $1.46 million per year. Based on informal discussions with taxi operators, this should be an attractive arrangement to them.

The total annual subsidy (excluding start up costs) would be approximately $3 million per year, therefore, for an operational test of CST (including parataxi services) in a community of 40,000 people. This would provide on the order of 7.3 million taxi/parataxi trips per year. This is an average subsidy of approximately 41 cents per total taxi/parataxi trip, or $150 per year per employee, or $75 per capita. Even if these subsidy levels were 'doubled, it would be an extremely low-cost way to reduce traffic congestion delays in low-density suburban areas. It also appears that most of these subsidies could be generated by some combination of employee parking fees, road pricing tolls, audiotex/videotex advertising, and traffic mitigation charges on new development.

Task 7 - Develop Transit, Paratransit and Ridesharing Information Specifications and Task 8 - Interstate Driver Information Capabilities

Section 1 - General Information on the California Smart Traveler (CST) System

Appendices B and C describe how audiotex and videotex systems work and how they can be used to obtain information about many subjects, including bus and rail transit schedules. Readers who are not familiar with these interactive technologies may wish to review Appendices B and C prior to reading the following 'sections. Readers may also wish to review Figure 6 prior to reading the following sections, which goes into considerable detail on the steps the CST System will take to process each request. Figure 6 shows that most users will soon need to press only one or two buttons to request information about the "best" ways to get between home and work, for example, by public transportation or by driving.

Section 2 - Advanced Rider Inform&ion Subsvstem (ARIS)

This section describes the interactive procedure by which the CST system obtains trip specifications from a rider and how it presents trip information to the rider. The four basic specifications that are required to obtain this information are the:

1. Rider's origin
2. Rider's destination .
3. Planned time of departure/arrival
4. Number of seats required (i.e. people traveling)

In order to reduce the input requirements on the rider, it will be possible for each rider to pre-store frequently-used trip specifications in his or her master file to make the system easier to use. For example, the master file could contain all the information required'to request a'ride, which would arrive by 8:30 AM, from the rider's home to his or her place of work. It will also be possible to store other rider characteristics - such as no smoking, hearing or visual impairment, a wheelchair user - to provide CST with the information necessary to provide the best transportation services to the rider.

The direct phone numbers for each ARIS service can be used to bypass intermediate steps and save the experienced user considerable time. There are two levels of ARIS services, (A) those for the general public and (B) those only for registered CST users:

2A. <u>General ARIS Services - NO CST Registration Required</u> (Direct Phone: XXX-X120)

These services provide information to the general public about:

2Al. Obtaining rides on scheduled bus and rail transit services, given the user's earliest time of departure.

2A2. Obtaining rides on scheduled bus and rail transit services, given the user's latest time of arrival.

2A3. Obtaining rides on taxis, airport shuttles and other conventional paratransit service.

2A4. Registering for conventional carpool and vanpool matching services.

2A5. Registering for special transit, paratransit and ridesharing services.

(Readers not interested in detailed descriptions of how to use each of these interactive services may skip to paragraph 2B on Page 33.)

2A1. <u>Obtaining information on scheduled bus and a 1 transit services. given the earliest time of departure</u> (Direct Phone: XXX-X121)

This section will describe how one can use an audiotex-based ARIS, sometimes called a Computerized Rider Information System (CRIS), to request information about non-restricted rides on a local public transportation system. Conceptually, this information will be retrieved from a matrix of reasonable (i.e. no more than three transfers) alternatives for each origin-destination pair for weekdays, Saturdays and Sundays and holidays. Once a request is entered from a touch-tone telephone keyboard, the computer system will examine the available alternatives and provide the user with information about the "best" rides available. The computer will use criteria specified by the user or historical rider preferences to find up to ten (10) rides that meet the caller's transportation needs.

The computer will first describe what it selected as the "best" trip for the user. The user can listen to information about the other nine trip possibilities by using the keys to work through the list of possibilities, The "F" (#3) key can be used to move FORWARD to the next ride description. The "R" (#7) key can be used to REPLAY any ride description and the "B" (X2) key can be used to work one's way BACK-UP to the previous ride description.

It should be noted that the term "bus" in this and the following sections (as in the German Ruf-Bus system) applies to maxi-buses (articulated buses),, mini-buses and micro-buses (i.e. contract taxis), which may be used on a route at different times. It should also be noted that telephone operators will be available at all times to assist in the event of a problem. However, there may be an pdditional charge for "operator-assisted" calls.

It is assumed that audiotex users have access to a map[4] that shows the numbers of all check-points[5] in the service area. In the future, videotex users will be able to display these maps on their CRT (video) screens.The following are the steps a user would take to obtain information about a ride from

---

[4]These maps will be available in the yellow pages, from the regional transit agency, and at many stores and newsstands.

[5]Checkpoint -. Any public transportation loading or unloading point. Although the discussion assumes each checkpoint has a unique four-digit number, checkpoint numbers can have more or fewer digits.

a regular[6] checkpoint to a regular or route-deviation checkpoint[7]:

1. The computer says: "Please enter "1" if you require a lift-equipped vehicle or a "2" if you do not". If "1" the computer will skip to Step 3. If anything other than a "1" is pressed (or if there is no answer within 5 seconds), the computer will assume a lift vehicle is not required and will continue to the next step.

2. The computer says: "Please enter a "1" if you would like to minimize walking distances, a "2" if you would like to minimize transfers, a "3" if you would like to minimize door-to-door travel time, or a "4" to get the lowest price. If anything other than these keys is pressed, the computer will assume a "4" has been selected.

3. The computer says: "Please enter your origin checkpoint number now." The user enters a four digit number. The system will not accept invalid checkpoint numbers, such as the number of a route-deviation checkpoint, as an origin checkpoint *for* unregistered users.

4. The computer says: "Please enter your destination checkpoint number now." The user enters a four digit number.

5. The computer says: "If you are interested in obtaining information about transit rides during the next 12 hours, press the "1" key". If you are interested in transit rides at other times, press the "2" key. If the user presses the "2" key, the computer skips to Step 9.

6. The computer says: "It is now (TIME) (AM/PM), on (DAY of WEEK). Please enter the earliest time you can leave the checkpoint as a four

---

[6]Regular checkpoint - A rail station, bus stop, etc. that is visited on a regular schedule and designated with a sign.

[7]Route-deviation checkpoint - Only visited during certain hours (e.g. off-peak, late night) at the special request of a transit user. These- checkpoints are also designated with a sign.

digit number. The first two digits are for the hour and the second two digits are for the minutes. For example, 9:45 would be entered as 0945". The user enters a four-digit number. The computer will calculate whether the time is AM or PM and the day of the week, since it is within 12 hours of the current time.

7. The computer will search through the origin-destination matrix for that day of the week and will tell the caller the scheduled (and estimated) time of the "best" bus or rail departure, the vehicle and/or route number, and the fare, transfer instructions, etc. The caller can repeat the information by pressing the "R" key. The caller can forward to information about the next alternative by pressing the "F" key. The procedure can be used repeatedly to explore other travel possibilities. The caller can also back-up to the previous alternative with the "B" key. (It should be noted that this is an information service only. No new transit trips will be added and no existing transit trips will be modified as a result of this audiotex inquiry.) If there is no keyboard activity for 5 seconds, the computer will proceed to the next step.

8. The computer says: "Please press "1" if you would like to get other transit information". If the user presses "1", the computer returns to Step 3. If the user presses any other key, or if 5 seconds elapse, the computer will terminate the call.

9. The computer says: "Enter "1" if you are interested in weekday transit information, "2" if you are interested in Saturday transit information, *or* "3" if you are interested in Sunday or holiday transit-information". The user enters 1, 2, or 3. Any other response, or no response for 5 seconds, will be treated as a "1".

10. The computer says: "Please enter the earliest time you can leave the origin checkpoint as a four-digit number". The user enters a four-digit number.

11. The computer says: "Please enter a "1" if

this time is AM or a"2" if this time is PM". The user enters a "1" or "2". Any other response or no response for 5 seconds; will be treated as a "2". The computer skips back to Step 7.

2A2. Obtaining information on scheduled bus and rail transit services, given the latest time of arrival (Direct. Phone: XXX-X122)

Since this procedure is almost identical to that in the preceding section, where the earliest time of departure is given, the steps will not be repeated here.

2A3: Obtaining information on taxis, airport shuttles and other conventional paratransit services (Direct Phone: XXX-X123)

For the initial demonstration of CST, this function will be handled by trained operators who will collect information from the .caller on origin, destination, size of traveling groups, requested departure time, amount of luggage, etc. and enter it into the computer. The computer will transmit information about the closest origin and destination checkpoints to all participating* paratransit operators who can provide transportation services between these checkpoints. The operator will review the "bids" received from these operators and will provide alternatives to the caller. After the caller has made a choice, the operator will transmit the name of the caller and the origin and destination addresses to the selected paratransit operator and will transmit "sorry" messages to all others who expressed an interest in providing the ride.

This approach assumes that most callers are not familiar with either the local area or with the full range of available local paratransit services, and that most would like to have an "agent" or "broker" help them obtain the most "cost-effective" service available. With a single phone call, this

*Participating paratransit operators are those that are properly insured and licensed to provide transportation services in part or all of the local CST service area and who have agreed to provide Caltrans a small commission for brokerage services.

agent could help them locate the closest available taxi, for example, or a less costly jitney *or* shuttle service. The agent would also let riders know the approximate cost and the approximate travel time when they call.

2A4. <u>Registering for conventional carpool and vanpool matching services</u> (Direct Phone: XXX-X124)

Calls for these services will be automatically transferred to the local rideshare matching agency.

2A5. <u>Registering for special transit, paratransit and ridesharing services (i.e. CST cards)</u> (Direct Phone: XXX-X125)

Calls for these services will be automatically transferred to the CST HELP desk to assist the caller in finding the most convenient registration office, since the applicant will need to be photographed and issued an account number, and an I.D. card, and register a four-digit personal identification number (PIN), which will serve as an electronic signature for future transactions. Perhaps these functions could be provided by California's Department of Motor Vehicles (DMV).

2B. <u>Restricted CST Services - CST Registration Required</u> (Direct Phone: XXX-X130)

Two important purposes for registering users of flexible-route public transportation services and issuing account numbers, identification cards and PINs, are to minimize "false alarms" (i.e. false requests for special transportation services) and to improve the security of both riders and drivers. The following is the procedure a user would follow to access any restricted ARIS services:

The computer will say, "Please enter your account number now". The user will enter his or her account number.

The computer will say: "Please enter your Personal Identification Code now". The user will enter the four digit PIN.

If the PIN is correct, the computer will skip to the users special request. If the PIN is not correct, the computer will ask the user to reenter it up to three (3) times. If the PIN number is still incorrect, the computer will advise the user that he or she is being disconnected because the "Personal Identification Code" is invalid. The computer will also record this possible attempt to obtain someone's PIN number and will take appropriate action, including special' monitoring programs or changing account numbers and PIN numbers.

Readers who own AT&T or other telephone credit cards will recognize that the procedure is very similar to that used to charge long-distance telephone calls. In fact, users may wish to use their telephone credit card PIN or bank credit card PIN as their CST personal identification number to make it easier to remember. The security procedure is also very similar to that used by the Charles Schwab brokerage firm to buy and sell stocks via its TeleBroker system and by the State of North Carolina for filing unemployment insurance claims.

Two other purposes for registering users is to make services easier to use and to minimize input errors. Registered users may prestore detailed definitions for mnemonic (i.e. easy to remember) codes and use these codes for:

Origin and destination checkpoints (e.g. HC = Home's (closest) Checkpoint = 1043; SC = School's (closest) Checkpoint = 2078).

Origin and destination addresses for door-to-door services (e.g. H = 23 Elm Street, Westwood; W = 1088 King Street, Santa Monica).

Ride definitions (e.g. HW = A ride from Home (e.g. 23 Elm Street,' Westwood) to work (i.e. 1088 King Street, Santa Monica), as soon as possible, one person (male).

The use of easy-to-remember codes, will make CST more convenient to use'and will reduce input errors. For example, users should find it much easier to remember the name of the checkpoint nearest home as "HC" rather than 1043. The use of mnemonic codes will also make it easier to request door-to-door and flexible-route transportation services. Rather than trying to use the touch-tone key-board to enter "23 Elm Street, Westwood", for example, each time a user wanted to use his or her home address as either an origin or a destination checkpoint, the user need only enter "H", which had earlier been registered as an individual' checkpoint code for that

'Individual checkpoints are special paratransit or ridesharing pickup and delivery points specified by a user. The location of each user's individual checkpoints will in be that user's address. Special user information, such as a wheelchair lift is required, will be available in the user's file record and will not need to be entered for each trip by the user.

The biggest time savings Will occur when using a mnemonic code to enter the complete description of a public transportation trip, particularly a trip that includes door-to-door service. The mnemonic code (up to six letter or numbers followed by a *) not only provides access to origin and destination information, it may also provide access to information on the requested time of departure or arrival, or the number of people in the traveling group. In the event of a minor change in travel plans, users will be able to modify the requested time of departure or arrival or the number of people in the traveling group by calling the telephone operator (i.e. pressing the "0" or "Operator" key). If the user requests a route-deviation or a demand-responsive ride (i.e., one that is not served on a regular transit route) and he or she does not show up, the user's account will be billed a penalty fee (e.g., $1.00), since the vehicle and driver had to make a special trip to meet the user's request.

Restricted CST services provide information to registered card holders and their guests about:

2B1. Obtaining rides on all available fixed-route, route-deviation and demand-responsive transit, paratransit and ridesharing services, given the user's earliest time of departure.

2B2. Obtaining rides on all available fixed-route, route-deviation and demand-responsive transit, paratransit and ridesharing services, given the user's latest time of arrival.

2B3. Obtaining rides on all available fixed-route, route-deviation and demand-responsive transit, paratransit and ridesharing services, given the user's prestored ride specifications.

(Readers not interested in detailed descriptions of how to use each of these interactive services may skip to Section 3 on page 38)

The following description assumes that the service area has fixed-route, route-deviation and demand-responsive modes of public transportation. If any of these modes are not available in the. service area, they will not be included in the evaluation of alternative modes and will not be offered to

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file records.

users.

2Bl. <u>Obtaining rides on all available fixed-route, route-deviation and demand-responsive public transportation services, given the user's earliest time of departure</u> (Direct Phone: XXX-X131)

This section will describe how one can use an audiotex-based CST system to request information about both restricted and non-restricted rides on a local public transportation system. The system will examine all the alternatives available between two checkpoints and will provide the user about the "best" rides available. The computer will use criteria specified by the user or historical rider preferences to find up to ten (10) rides that meet the caller's transportation needs.

The computer will first give the user its "best" trip recommendation. The user can use the "F" and "B" keys on the telephone to work his or her way forward or back through the list of rides descriptions or the "R" key to repeat any ride description. It should be noted that telephone operators will be available at all times to assist the user in the event of a problem. However, there may be an additional charge for "operator-assisted" calls. The following are the steps a registered CST user would take to obtain information about a ride from an individual checkpoint (e.g. work address) to the regular checkpoint closest to the individuals home:

1. Enter CST account number and PIN. If invalid after 'three trips, take appropriate security precautions and disconnect user. If valid, continue.

2. Enter origin checkpoint code or number. User enters "W", which has been defined in the user's CST file by his or her work address (i.e. possibly a numbered stall in the employee's parking lot).

3. Enter destination checkpoint code or number. User enters "CH", which has been defined in the user's CST file as regular checkpoint 3314.

4. Enter the number of people in traveling group. User enters a one. or two digit number. This information is important in dispatching a large enough vehicle or sufficient vehicles to accommodate the traveling group since the CST computer can dispatch a dial-a-ride minibus or even a contract taxi if this is the most cost-effective approach. Since the caller in this example specified an origin checkpoint that was not a

regular transit checkpoint or a route-deviation checkpoint, it is likely that he or she will be picked up by a small paratransit/ridesharing vehicle.

5. Enter the earliest time of departure. The user enters a four digit number and, if necessary, a code to indicate whether the time is AM or PM.

6. The CST computer will search through the public transportation alternatives available and will prepare a "list" of up to ten (10) that meet the criteria specified by the user (e.g. guaranteed seating, no transfers) in his or her CST file. The computer will first give the user its "best" trip recommendation. The user can use the "F" and "B" keys to search through the list and can select the "one" that he or she prefers by pressing the "#" key immediately after the trip description is read by the ARIS computer.

7. The CST computer Will then ask if the registered user would like to get additional information. If "yes" , the computer will return to Step 2. If "no" , the computer will terminate the call.

Several points should be noted in this example. Firstly, the system will not only. examine scheduled transit alternatives for a registered user, it will also examine paratransit and ridesharing alternatives. Secondly, if the user does not specify a regular or route-deviation checkpoint as the origin or destination for a public transportation trip, the CST computer will probably assign a small-vehicle paratransitor ridesharing service with guaranteed seating. Thirdly, for registered users, CST is both an information service and a reservation/transaction service. As soon as the user presses the "#" key (See Step 6), CST accepts this as an electronic signature for an order for transportation services. If the user does not show up to accept the ride, his or her account will be charged a penalty fee. Note: If the ride is on a scheduled transit vehicle between two regular checkpoints, it is not considered a transaction because no additional vehicle was either dispatched and no existing vehicle was re-routed.

2B2. <u>Obtaining rides on all available fixed-route, route-deviation and demand-response public transportation services, given the user's latest time of arrival.</u> (Direct Phone: XXX-X132)

Since this procedure is almost identical to that in the preceding section, where the earliest time of departure is given, the steps will not be repeated here.

2B3. <u>Obtaining rides on all available fixed-route, route-deviation and demand-response public transportation services. given the user's prestored ride specifications</u>. (Direct Phone: XXX-X133)

The following are the steps a registered user would take, for example, to obtain information about door-to-door service between home (H) and work (W):

1. Enter account number and PIN. If invalid after three tries, take appropriate security precautions and disconnect user. If valid, continue.

2. Enter a prestored ride specifications code (up to 6 characters or digits followed by a *), which will provide origin checkpoint number,' destination checkpoint number, number of persons in traveling group, and requested time of departure/arrival.

The computer will search through the public transportation alternatives available and will prepare a "list" of up to ten (10) that meet the criteria specified by the user in his or her file. The computer will first give the user its "best" trip recommendation. The user can use the "F" and "B" keys to search this list and can select the one that he or she prefers by pressing. the "#" key immediately after the trip description is read by the CST computer.

A videotex-based Advanced Rider Information Subsystem (ARIS) would closely follow the preceding steps for an audiotex-based subsystem and will not be discussed further in this report. It should be noted, however, that videotex systems will be more user-friendly and will provide many more capabilities than audiotex systems in the future.

Section 3 - <u>Advanced Driver Information Subsystem (ADIS)</u>

As in the case of requests for parataxi rides, four basic specifications are required for drivers to offer parataxi rides, These, are the:

1. Driver's origin
2. Driver's destination
3. Planned time of departure/arrival
4. Number of seats available (i.e. passenger capacity)

These same trip specifications can also be used to give a driver more timely and accurate information about traffic conditions between his or her origin and destination or to recommend the best routes between the origin and destination. It will also be possible for each driver to pre-store frequently used trip specifications in his or her master file to make the system easier to use.

There are also two levels of ADIS services, (A) those for the general public and (B) those only for registered CST users:

3A. <u>General ADIS Services - No CST Registration Required</u> (Direct Phone: XXX-X140)

These services provide information to the general public about:

3Al. Traffic conditions between any two market (regular or route-deviation) checkpoints, given the driver's planned time of departure.

3A2. Traffic conditions between any two marked checkpoints, given the driver's planned time of arrival.

3A3. Latest traffic conditions on major roads or highways.

3A4. Public parking facilities near any marked checkpoint.

3A5. Registering for conventional carpool and vanpool matching services.

3A6. Registering for special driver information services (i.e. CST registration procedures).

(Readers not interested in detailed descriptions of how to use each of these interactive services may skip to paragraph 3B oa Page 43.)

3Al. <u>Obtaining information on traffic conditions, between any two marked checkpoints, given the planned time of departure</u>. (Direct Phone: XXX-X141)

This section will describe how one can use an audiotex-based CST to request information about traffic conditions between any two points in the service area. Conceptually, this information will be retrieved from a matrix of reasonable routes for each origin-destination pair for morning commuting hours, midday, afternoon commuting hours and other times. Once a request is entered from a touch-tone telephone, keyboard, the computer system will examine the available alternatives and will provide the user with information about the "best" routes available. The computer will use criteria specified by the user or historical driver preferences to find up to ten (10) routes that meet the caller's travel needs.

The computer will first describe what it has selected as the "best" route for the user. The user can listen to information about the other route possibilities by using the "F" and "B" keys to work his or her way through the list of possibilities. The "R" key can be used to repeat any route description. The following sections will describe how to use an audiotex-based Advanced Driver Information Subsystem (ADIS). It should be noted that telephone operators will be available at all times to assist the user, in the event of a problem. However, there may be an additional charge for"operator-assisted" calls.

It is assumed thatusers have access to a map that shows the numbers of all check-points in the CST service area. The following are the steps a user would take to obtain information about traffic conditions between two marked checkpoints:

1. The computer says: "Please enter "1" if you are driving a motorcycle, automobile, van or small truck or a "2" if you are driving a larger vehicle. If anything other than a "1" is pressed (or if there is no answer within 5 seconds), the computer will assume the caller is using a larger vehicle and will skip to Step 2. This feature is necessary because, some large trucks are excluded from some streets, neighborhoods, bridges, etc. at certain times.

2. The computer says: "Please enter "2" if you are a two-axle truck, "3" if you are a three-axle truck or trailer-truck, or "4" if you are larger. If anything other

than a "2" or "3" is pressed, the computer will assume a "4" has been selected.

3. The computer says: "Please enter the number of the checkpoint closest to your point of origin". The user enters a four-digit number.

4. The computer says: "Please enter the number of the checkpoint closest to your destination point." The user enters a four-digit number.

5. The computer says: "If you are interested in obtaining information about traffic conditions during the next 12 hours, press the "1" key. If you are interested in traffic conditions at other times, press the "2" key. If the user presses the "2" key, the computer skips to Step 9.

6. The computer says: "It is now (TIME) (AM/PM) or (DAY OF WEEK). Please enter your planned time of departure as a four digit number now." The user enters a four-digit number.

7. The computer will search through the origin-destination matrix for that day of the week and time period and will tell the caller the "best" route between the two checkpoints. The user can hear about alternative routes by us of the "F" key and the "B" key,as described previously. The computer will terminate the call after five minutes.

8. The computer says: "Please press "1" if you would like information about public parking near your destination (checkpoint). If the user presses "1", the computer skips to Step 2 of Section 3A4 - requesting information about public parking facilities. If the user presses any other key, or if 5 seconds elapses, the computer will terminate the call.

9. The computer says: "Enter "1" if you are interested in morning commuter hours traffic information, "2" if you are

interested in midday traffic information, "3" if you are interested in afternoon commuter hours traffic information or "4" if you are interested in traffic information at other times. Any other responses, or no response for 5 seconds, will be treated as a "4".

10. The computer says: "Please enter the earliest time you can leave the origin checkpoint as a four-digit number." The user enters a four-digit number.

11. The computer says: "Please enter a "1" if the time is AM or a "2" if this time is PM." The user enters a "1" or "2". Any other response, or no response for 5 seconds will be treated as a "2". The computer skips back to Step 7.

3A2. <u>Obtaining information about traffic congestion. given the planned time of arrival</u>. (Direct Phone: XXX-X142)

Since the procedure is almost identical to that in the preceding section, where the planned time of departure is given, the steps will not be repeated here.

3A3. <u>Obtaining the latest information about traffic congestion on a numbered roadway</u>.

• The computer will list the major routes, in order of popularity, and ask the user to enter a "1" as soon as he or she hears the name or the number of the route of interest. As soon as the "1" is pressed, the computer will describe the traffic conditions in both directions or the route. The user can move forward or backward through the list with the "F" or "B" keys.

3A4. <u>Obtaining information about public parking **facilities near any [redacted]ked (i.e. regular or route-d[redacted]viation) checkpoint**</u>. (Direct Phone:

1. The computer will say: "Enter the marked checkpoint number closest to your destination". The user enters a four-digit number.

2. The computer will search its files and give the caller a list of the. addresses of the "best" parking facilities close to the (destination) checkpoint.

3. The user can use the "F" and "B" keys to work his or her way forward and backward through the list.

3A5. Registering for conventional carpool and vanpool matching services. Direct Phone: XXX-X124)

Calls for these services will be automatically transferred to the local rideshare matching agency. (NOTE: This is the same as Section 2A4).

3A6. Registering for special driver information services (i.e. CST registration proceduresl. (Direct Phone: XXX-X125)

Calls for these services will be automatically transferred to the CST registration agency. (NOTE: This is the same as Section 2A5).

3B. Restricted ADIS Services - CST Registration Required. (Direct Phone: XXX-X150)

As in the case of the Advanced Rider Information Subsystems (ARIS), all of the above information services require the user to have a CST account number, identification card and personal identification number (PIN). Each restricted ADIS request will require the user to go through the same security procedures as previously described for APIS requests. The registered CST user will also be able to learn of opportunities to offer parataxi rides if he or she has been authorized to serve as a parataxi driver.

In order to further increase security, parataxi drivers will be required to enter a prestored vehicle code which will identify which vehicle the driver will be using if he or she owns multiple vehicles and will serve as another password. The vehicles description, including make, year, model, color and license "number" will be transmitted to approved parataxi riders after the CST files have been checked to determine that the vehicle has not been reported as stolen, that the vehicle is still properly insured, that the vehicle has a valid safety certificate, etc.

Restricted CST services provide information to registered cardholders and parataxi drivers about:

3B1. Traffic conditions and parataxi ride offer opportunities between any two checkpoints, given the driver's planned time of departure. Checkpoints can be marked or unmarked (i.e. individual).

3B2. Traffic conditions and parataxi ride offer opportunities between any two checkpoints, given the driver's planned time of arrival.

3B3. Traffic conditions and parataxi ride offer opportunities between the two checkpoints specified in a user's prestored trip description.

(Readers not interested in detailed descriptions of how to use each of these interactive services may skip to Section 4 on Page 46.)

3Bl. <u>Obtaining information about traffic conditions and parataxi ride offer opportunities between any two checkpoints. given the planned time of departure</u>. (Direct Phone: XXX-X151)

The first ten (10) steps of this procedure are almost exactly the same as those described for unregistered CST users to'obtain information about traffic conditions between two marked checkpoints (See Section 3 Al). Instead of limiting users to marked checkpoints, however, they will also be allowed to use unmarked (i.e. individual) checkpoints and mnemonic names or codes for checkpoints. In addition, instead of disconnecting the user or transferring the user back to the main ADIS audiotex menu after the traffic congestion information is presented, the system will add the following steps:

11. The computer says either "There is no registered person looking for a parataxi ride" and returns to the main ADIS menu or "There is a registered person looking for a parataxi ride in your planned direction. If you are interested enter your vehicle identification code". The driver enters a two character/ digit code for the vehicle he or she plans to drive.

12. If the vehicle identification code is valid, the computer will go to the next step. If the code is not valid, the computer will ask the user to reenter it up to three (3) times. If the code is still incorrect, the computer will

advise the user that he or she is being disconnected because the "Vehicle Identification Code" is invalid. The computer will also record this possible attempt to obtain someone's vehicle identification code and will take appropriate action, including special monitoring programs or changing account numbers. PIN numbers, vehicle identification codes, etc.

13. The computer says: "Please pick up (Mr./Mrs. ______), a party of (______) at (__________) (marked checkpoint number if available) between (________) and (_______) and deliver (him/her) and his/her companion(s) to (_______________). It -is - now (time). (His/Her) identification card number is (_________). This message may be repeated by pressing the "R" button or your touch tone telephone".

14. The computer says: "Please enter "#" if you agree to agree to give (Mr./Mrs.) __________ a parataxi ride". If the user enters anything but a "#" the computer will disconnect the call. If the user enters a "#", the computer will say, "Thank you for ridesharing" and go to the next step.

15. The computer will record the transaction, debit the rider's account, credit the driver's account, and remove their names from the active parataxi lists and disconnect the call.

3B2. <u>Obtaining information about traffic congestion and ride offer opportunities between any two checkpoints given the planned time of arrival</u>. (Direct Phone: XXX-X152)

Since this procedure is almost identical to that in the preceding section, where the planned time of departure is given, the steps will not be repeated here.

3B3. <u>Obtaining information about traffic congestion and parataxi ride offer opportunities, given the driver's prestored trip specifications</u>: (Direct Phone: XXX-X153)

The following are the steps a registered CST driver would take, for example, to obtain information about traffic conditions and parataxi ride offer opportunities between work (W) and home (H):

1. Enter CST's account number and PIN. If invalid after three tries, take appropriate security precautions and disconnect user. If valid continue.

2. Enter a prestored ride specifications code (e.g. W/H) which will provide origin checkpoint number, destination checkpoint number, number of persons in traveling group, and requested time of departure/arrival.

3. Enter the appropriate vehicle code when requested. The system will search through the best routes between the origin (W) and destination (H) and provide a report of traffic conditions. The CST computer will then advise the driver if there is a registered user waiting for a parataxi ride in his/her direction. If the driver is interested in providing a ride, the system will also provide pickup and delivery instructions.

A videotex-based Advanced Driver Information Subsystem (ADIS) would closely follow the preceding steps for an audiotex-based subsystem and will not be discussed further in this report. It should be noted that videotex systems will be more user friendly and will provide many more capabilities than audiotex systems in the future.

Section 4 - <u>Additional Comments on the Design of CST</u>

Figure 10 describes the flow of information for processing of parataxi ride offers and ride requests in CST. Figure 10 could be modified to allow private operators to offer supplementary fixed-route and route-deviation transportation services using automobiles, vans, minibuses or even large buses. In Jerusalem, for example, taxis are allowed to operate as jitneys along existing bus routes during peak commuting hours. Although their fares are higher than government-operated buses, the fixed-route taxis provide guaranteed seating, have shorter headways and make fewer stops to pick up and drop off passengers. These jitney services are popular with both riders and government officials who are faced with tight budgets. A similar approach in the U.S. would enable many communities to provide extra transit capacity during peak commuting hours at a low cost to taxpayers.

Although CST is designed to give the driver information before he or she starts a trip, it can easily be modified to notify the driver of important changes (e.g., traffic accident delay, parataxi ride cancellation) while enroute, if the driver's vehicle is equipped with a mobile terminal, such as a cellular telephone or a notebook computer. The availability of PCN "telephones" in the future will also be able to alert riders of any changes in their scheduled parataxi driver's plans.

FIGURE 10

PARATAXI TRANSACTION PROCESSING

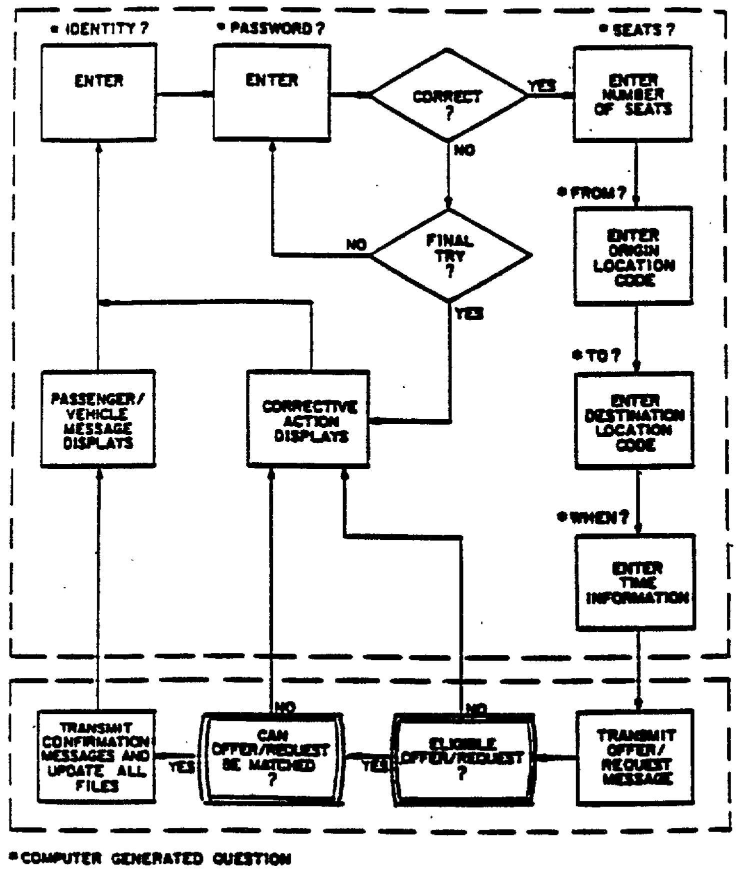
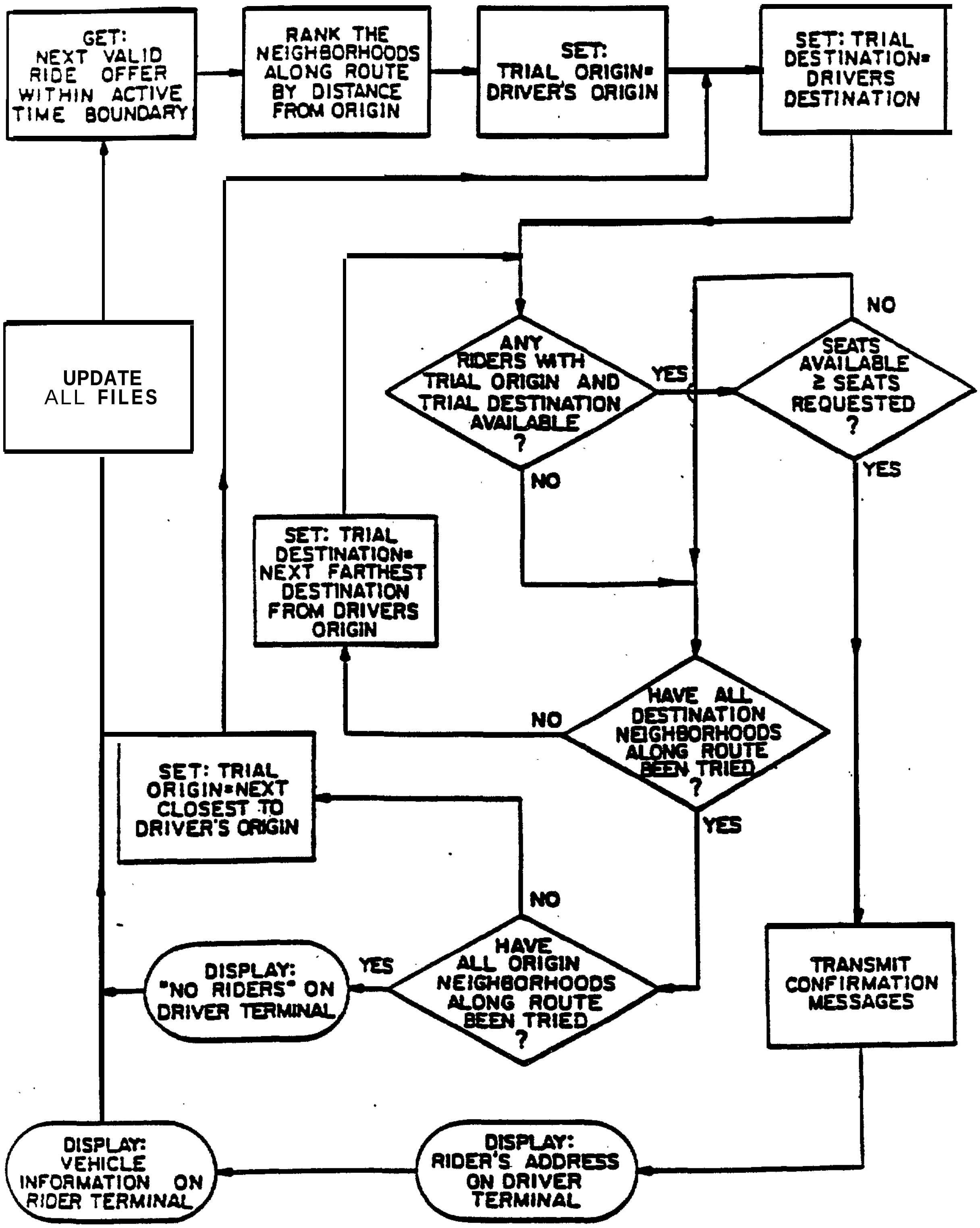


Figure 11 describes the procedure that could be used to match parataxi drivers and riders. In this flowchart, it is assumed the. parataxi service area is divided into a square grid. The procedure attempts to find riders that are as close as possible to the driver's origin in order to minimize rider waiting times. In fact, it will first look for riders that have origins in the same square as the drivers origin. If no match is found, it will move to the next square in the direction of the driver's destination. Figure 11 could be modified to use non-square grids, polar coordinates, etc. if this is a more convenient way-to handle the matching process for the available data.

Task 9 - Evaluate Test Sites

One of the objectives of this study was to meet with Caltrans personnel in San Diego, Orange County, Los Angeles, San Francisco and Sacramento to identify suburban sites that would be well suited

FIGURE 11
MATCHING PARATAXI RIDE OFFERS AND REQUEST



for conducting operational tests of CST and parataxi services. The following are some of the characteristics of attractive test sites:

1. Severe and growing traffic congestion problems.

2. Employers with experience in computers, telecommunications and related high-tech businesses who might wish to be private-sector partners with USDOT/FTA, Caltrans and other organizations.

3. Local government, business and community leaders who have exhibited a willingness to try innovative approaches to solve their transportation problems.

4. Availability of good baseline data.

Only suburban sites were considered in this study because of their increasing traffic congestion problems and the difficulty of providing cost-effective bus and rail transit services in these low-density areas. Appendix D contains a summary of the names and titles of the Caltrans personnel who participated in these meetings.

Meetings were then held with government, business and community leaders in each of the areas suggested by Caltrans to let them know about this study and the possibility that their city, transportation management association (TMA), business park, etc. might be invited to participate in a CST demonstration project. Appendix D also contains the names and affiliations of these people. Material was collected about the most promising test sites and analyzed. Working papers were prepared about the following five (5) sites:

1. UCLA/Westwood
2. Tri-Valley Area, including San Ramon, Pleasanton and Livermore
3. North City TMA Area
4. Roseville
5. Simi Valley

The following are descriptions of UCLA/Westwood and Pleasanton/San Ramon from a study financed by the Federal Highway Administration (Ref. 7) that provides excellent baseline data:

1. <u>UCLA/Westwood in the Los Angeles Metropolitan Area</u>
UCLA is located in Westwood area of Los Angeles. Some 34,000 students attend UCLA, and over 18,000 people work on campus. Westwood is a diversified major activity center, with restaurants, retail and office activity, plus an affluent residential community of about 37,000. Traffic in Westwood is extremely congested, and the community has maintained pressure on the University to manage the traffic generated by its

student and employee population. The University had developed a comprehensive management program which includes strategic use of its parking facilities, express and shuttle bus services, a carpool program and an extensive vanpool program."

2. <u>Tri-Valley in the San Francisco Metropolitan Area,</u> including three large employment centers in San Ramon, Pleasanton and Livermore.

   A. <u>San Ramon, particularly the Bishop Ranch Business Park</u>

   "Bishop Ranch is a modern business park located at the eastern fringe of the San Francisco metropolitan area, near the town of San Ramon, in Contra Costa County. Bishop Ranch is about 35 miles from San Francisco, and the area in which it is located is of extremely low density. It has become the home of several major organizations with significant employment space requirements, such as Pacific Bell and Chevron, which were formerly located in San Francisco. the park has been in existence since the early 1980s, and its employment, which is predominately white collar professional, numbers 14,000. Bishop Ranch's two primary developers were placed under a requirement by Contra Costa County to reduce their peak hour vehicle trips by 40%. They have satisfied this requirement through a combination of alternative modes and flexible work hours, with a significant role played by flextime. Helping the large number of employees in the relocation to the new office space was an important factor influencing early success of the program. A TMA has been formed in Bishop Ranch to assist with the transportation management program. The TDM program of Pacific Bell is an exemplary individual effort."

   B. <u>Pleasanton, particularly the Hacienda Business Park</u>

   "Hacienda Business Park is a very similar situation to Bishop Ranch. It is located just south of Bishop Ranch, along I-680 in Alameda County. Hacienda is located near the town of Pleasanton, which effected a TDM ordinance'in conjunction with the planning of Hacienda, to limit the traffic impacts of the new development. The ordinance requires a 40% reduction in peak period vehicle trips for all large employers, and it applies to the entire city of Pleasanton as well as Hacienda. The employment at Hacienda is just under 8,000 and the City of Pleasanton, including Hacienda, has an employment of about 22,000.

Hacienda has achieved its reduction goal through a combination of alternate mode programs and flexible work hours, with most of the reductions achieved through time shifting. Again, relocation assistance was important to the success the TDM program. Within Hacienda Business Park, the program of AT&T serves as another exemplary individual effort."

C. <u>Livermore, particularly the Lawrence Livermore National Laboratory</u>

The Lawrence Livermore National Laboratory employs 7,000 workers and the Sandia National Laboratories employees another 1,000 workers. These laboratories have large carpooling and vanpooling programs. They also have a large percentage of knowledge workers who use computers at their jobs and have personal computers in their homes. Most if not all of these workers have also undergone extensive background investigations before being allowed to join the work forces of these laboratories. The security level among these employees should be very high.

It may also be desirable to include the City of Dublin in with San Ramon Pleasanton and Livermore to provide a contiguous test area.

It should be noted that the UCLA/Westwood site is covered by Regulation XV and both San Ramon and Pleasanton in the Tri-Valley area are covered by traffic mitigation ordinances which require major employees to develop programs to discourage the use of single-occupant automobiles by their employees. The following is a brief description of the other three sites recommended to Caltrans and USDOT/FTA as attractive sites for operational tests of CST:

3. <u>North City TMA in the San Diego Metropolitan Area</u>

This'rapidly-growing, medium-density, suburban employment and residential area in San Diego is bounded by Highway 52 to the South, the Pacific Ocean to the West, Del Mar Heights Road to the North and Camino Santa Fe to the East. Major employers include SAIC, UC-San Diego, University Town Centre, Scripps Memorial Hospital and First Capital Life Insurance. These and other employers have established the North City Transportation Management Association (TMA), which provides collectively-financed products and services designed to meet the needs of over 40,000 employees in the area. Because of (a) this hard-working and imaginative TMA, (b) the lack of good public transportation for suburb-to-suburb travel, and (c) a large retirement community in LaJolla, the North City area could provide several groups of 5,000-10,000 people to test audiotex-based parataxi services for both commuter and E&H

transportation services. Regulation XV-type ordinances are also in the process of being implemented throughout San Diego, which will provide incentives for employer participation in operation tests of innovative concepts.

4. Roseville in the Sacramento Metropolitan Area

This rapidly growing residential and employment center is located 20 miles northeast of Sacramento on I-80. Major employers include Hewlett Packard (HP), Southern Pacific, Roseville Community Hospital, NEC Electronics and Roseville Telephone. The City of Roseville currently has a population of 42,000. However, this is expected to more than double within the next 20 years. If either HP or the Sacramento Bee (which provides general-purpose audiotex services throughout the Sacramento metropolitan area) become interested in CST or other IVHS programs, Roseville would be an excellent site to test audiotex-based strategies for dealing with travel between the suburb and the central city -(i.e. Sacramento) as well as intra-suburb travel. A TMA was established in Roseville in 1990-1991 and traffic mitigation ordinances are now being implemented. Roseville also has a small bus fleet which could economically be converted to "smart" buses.

5 Simi Valley in the Los Angeles Metropolitan Area

This community is located 40 miles northwest of Los Angeles in Southeast Ventura County and is adjacent to the Western perimeter of the San Fernando Valley. It currently has a population of approximately 100,000 and has a small fixed-route minibus system and a dial-a-ride system. Major employers include the Simi Valley Unified School District, Farmers Insurance, First Interstate Bancard, Simi Valley Adventist Hospital, Micom Systems, Whittaker Electronic Systems and Wambold Furniture. Simi Valley also has an extensive vanpool program to transport residents to the San Fernando Valley and to Los Angeles. A TMA was organized in 1990. Because of both its isolation and growing traffic congestion problems on Highway 118, Simi Valley would be an excellent site to test the capabilities of an audiotex/videotex-based ATIS to integrate transit, paratransit and ridesharing services in a medium-sized urbanized area.

California has many other urban, suburban and rural communities that would also be excellent test sites for operational tests of CST.

Task 10 - Prepare Final Report/Slide Presentation

This document is the final report of Phase I, of the California Smart Traveler (CST) project. The script for the slide presentation about CST and parataxi concepts is available as a working paper. The slides show CST-like systems already operating successfully in Germany and outline the expected performance of parataxi systems (i.e., Figures l-5) in U.S. communities. The slide presentation was prepared to brief business, government and community leaders who live in or near possible CST test sites.

CONCLUSION

Almost all of the major telecommunications companies (e.g. AT&T, GTE, PacBell, Ameritech, US West) and almost all of the major computer companies (e.g. IBM, DEC, UNIVAC) provide or will soon provide audiotex/videotex systems and services that could be used for CST. Some of the hardware and software for these systems were developed in-house, others purchased them on an OEM basis from smaller companies, such as some of those listed in Appendix D. There are also a number-of information services companies, such as COMPUSERV, Prodigy, GE Information Services and Dun & Bradstreet, who could adapt their systems to include CST capabilities.

If carefully-designed demonstration projects show that CST can provide a way to reduce traffic congestion, gasoline consumption, air pollution and mobility problems in a cost-effective manner, it will create a large market for audiotex- and videotex-based CST systems. The volume of daily parataxi transactions and the volume of requests for information from both drivers and riders would make the market for CST systems much larger than the market for 9-l-l systems and airline reservations systems.

The widespread availability of CST would enable many families to save hundreds of dollars a month by eliminating the need for a second or third car. It would also. enable many other families to earn $50 to $150 a month by providing parataxi services for neighbors and co-workers. Families should be more than willing to spend $lO-$30 *per* month on CST and other audiotex and videotex services if they can save/earn considerably more than these information services cost.

Moreover, if CST capabilities are included in a multi-purpose community information system - which include home-banking,. teleshopping, electronic mail and a variety of other audiotex and videotex services - the market for computer and telecommunications hardware, software and services could reach billions of dollars a year. In addition to creating a wide variety of new business, employment, education and recreation opportunities, these community information systems could further reduce the need for travel, particularly single-occupant vehicle travel during peak commuting hours.

The CST specifications contained in this report should be viewed as a first draft. It is assumed that these specifications will be modified after they are reviewed by business, government and community leaders of communities that will serve as test sites for

CST and other IVHS concepts. It is assumed that these specifications will be further modified after they are reviewed by the marketing and technical staffs of companies (e.g., computer manufacturers, telephone companies, systems integrators, information service providers) that are interested in teaming with Caltrans, USDOT/FTA and others to develop and sell CST.

APPENDIX A

TRANSPORTATION RESEARCH RECORD 1280

Predicting Consumer Demand for Alternative Transportation 'Services Among Suburban Commuters

KEVIN J. FLANNELLY AND MALCOLM S. MCLEOD, JR.

A survey of suburban commuters revealed that their interest in ridesharing and related transportation system management (TSM) strategies, other than flextime, was minimal. The disincentive of high parking costs did not appear to be sufficient to attract riders to standard transit services. Enhanced service, however, provided., an important incentive for transit use. even when disincentives were comparatively low. Improvements in service, including express buses. reduced access time, and guaranteed seating, an induce automobile commuters to use alternative transit or paratransit. Moreover, decentralization of service from its downtown focus could open up a sizeable market for alternative transit both among carpoolers and solo drivers. Interest in alternative transit with improved service characteristics is directly related to commute time. Thus, increases in traffic congestion may stimulate demand for alternative transit, even at higher fares. The balance between service and fare that will optimize ridership can be easily deduced for various markets. Demand-response transit services appear to provide a feasible and profitable transit alternative, particularly if they are linked to a computerized, real-time. booking and dispatching network.

Commuters from East Honolulu experience high levels of traffic congestion along the only direct route to the island's major employment centers. A survey conducted in an eastern suburb of the island of Oahu was designed to explore the potential of various transportation system management (TSM) strategies for easing this congestion.

Of particular interest was commuters' inclination to use alternative forms of transit. Fares, service characteristics, hour of travel (with respect to peak-hour congestion), ease of access, miles traveled, and commute time all have been shown to influence mode split and transit ridership (1-3). The purpose of the East Honolulu survey was to assess the relative contributions and interactions of these factors on choice of mode and potential demand for alternative transit modes.

METHODOLOGY

Under the aegis of the Hawaii Department of Transportation, all 8,900 or so households in the section of East Honolulu shown in Figure 1 were contacted by mail. Because virtually the entire study area is owned by a single developer. a commercial list of all mailing addresses in the specific area of interest was readily available.

Center for Psychosocial Research, 777 Kapiolani Boulevard. Suite 1824. Honolulu, Hawaii 96813.

A total of 3,322 households in the target population completed and returned their questionnaires a response rate of 37 percent.

Most of the households in the sample (79.2 percent) consisted of three or four people, and only 13.5 percent were larger. The majority of respondents (60 percent) were between 30 and 50 years d age; 6.7 percent were younger, and 33.4 percent were older. Roughly two-thirds of respondents (64.4 percent) were male, and more than 99 percent had a driver's license.

The questionnaire elicited data on the demographic characteristics of respondents, their present commuting habits, and their attitudes toward and interest in using different travel alternatives. Most of the questions, especially those dealing with travel alternatives, required participants to rate their opinions and judgments on a scale of 0 to 10 (4,5). This rating scale allows people to assign a specific, subjective value to their attitudes, and it is particularly valuable in asking people about their probable future behavior (6). The ratings can be assumed to reflect respondents' own subjective probability of choosing a given behavioral alternative under the conditions stated in the question (4). For example, a rating of 10 assigned to the likelihood of using an express bus at a $1.00 fare is assumed to indicate 100 percent certainty that the respondent would use an express bus at $1.00 fare. A rating of 0 to the same item expresses certainty that the respondent will not take an express bus; that is, that the respondent's subjective probability of using an express bus is zero under given conditions.

To obtain demand estimates from these data, each rating was multiplied by 10. The average, or mean. likelihood score (the rating times 10) for any question provides an estimate of the percentage of people that are likely to use a given alternative. The standard deviation of the mean was used to calculate an error of estimate (the standard error of the mean). Although the relationship between respondents' likelihood scores and their actual behavior has yet to be validated, this method should prove to be more accurate than other commonly used scaling methods for determining consumer preferences.

Continuous variables, such as travel time and the attitudinal and behavioral ratings, were analyzed by parametric techniques, such as analysis of variance (ANOVA). Unweighted means ANOVA was used for most purposes to correct for disparities in sample sizes when participants were classified into subgroups such as carpool or solo driver. Wherever pos-

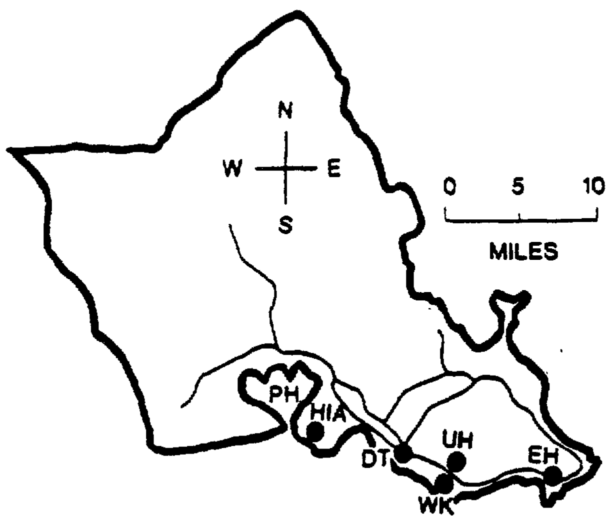


FIGURE 1 Primary highways on the island of Oahu and major work sites of commuters from the East Honolulu study area.

ssible, the data were analyzed by factorial designs so that the effects of several independent variables could be examined simultaneously. other parametric and nonparametric statistics were used as necessary.

RESULTS

Among those defined as commuters (that is, those living farther than 1 mi from work), 44.1 percent traveled roughly 10 mi from home to work in downtown, an area approximately 1 mi square that includes the capitol district, where most state and municipal offices are located. An additional 13.1 percent worked within 2 mi east or west of downtown (8 to 12 mi travel from East Honolulu), excluding Waikiki, part of which is within this 2-mi range. About 7.7 percent worked in Waikiki, a major tourist center southeast of downtown. Another 12.7 percent of commuters worked in the area east Pearl Harbor that includes commercial and industrial establishmeats near the Honolulu International Airport. These work sites are 5 to 6 mi west downtown, 15 mi or more from East Honolulu. Slightly more than 10 percent of the commuters traveled more than 20 mi each way to work.

Because of the topography of Oahu, all but 1.2 percent of the responding commuters made their daily commute along the same corridor into downtown, much of it on a single suburban arterial. Hence, in addition to the 44.1 percent working downtown, 29.1 percent of the commuters traveled the same route to get to jobs west of downtown, and another 19.2 percent traveled 7 mi or more with other inbound traffic each morning to reach job locations east of downtown. Given this situation, the geographical relationship of commuters' work sites with respect to downtown might be expected to have a more profound influence on commuter behavior than commute distance alone, although the two factors are closely related in this case (7).

Approximately 92.7 percent of commuters responding to the survey traveled to and from work by at, 6.4 percent took a bus, and fewer than 1 percent walked or rode a bicycle or motorcycle. Roughly 67.1 percent of all commuters said they drive alone, while 11.7 percent were in two-person carpools. 7.5 percent were in three-person carpools. and 6.4 percent were in carpools of more than three people. Nearly 80 percent (78.9 percent) of the people who carpool did so only with family members, another 12.9 percent were in carpools with people who are not family members, and the remaining carpoolers commuted with both family and nonfamily members.

Work Location and Mode Choice

No significant differences were found among modes with respect to commute distance. The average one-way travel distances of bus and car commuters were comparable (10.9 and 11.4 mi. respectively), and no differences in commute distance were found between carpools and solo drivers or among the different types of carpools (family, nonfamily, mixed). The location of work sites with respect to downtown. however, was found to exert a significant influence on choice of travel mode.

Generally, the closer people work to downtown, the greater their likelihood of riding the bus ($p < 0.001$). Only 4.4 percent of people that work 2 to 4 mi east of downtown commuted by bus, whereas 8.9 percent of people working within 2 mi of downtown were bus riders. Bus ridership was highest (12.0 percent) among those who work in downtown, but it was lowest (1.6 percent) among commuters working west of downtown.

A similar trend was found in carpooling. Among car commuters who worked more than 4 mi east of downtown, some 70.4 percent drove alone. This proportion decreased approaching downtown from the east, reaching a low of 67.9 percent solo driven among car commuters who work downtown. Once past downtown, the percentage of solo drivers rose significantly again, to 77.7 percent ($p < 0.001$). No relationship was found between work location and types of carpools.

Transit Service

Clearly, for the commuters surveyed, mode choice was more a function of destination than of distance. The results further suggest that the decision to use transit is also a function of service. Among the commuters that rode the bus, 17.6 percent worked downtown and 9.4 percent worked at the University of Hawaii, the only two work sites having express bus service from East Honolulu. The sparsity of ridership among people working west of downtown may reflect the lack of express service to these work sites, the need to change buses to travel west of downtown on some bus routes, or both.

The importance of express bus service in the decision to use mass transit is made more evident by comparing bus ridership to the university, which is about 2 mi due east of downtown, with that to Waikiki, which stretches from about 1.5 to 3 mi southeast of downtown and does not have express bus service. Only 2.1 percent of the commuters surveyed traveled by bus to work in Waikiki ($p<0.001$), even though the price of parking in Waikiki was about 35 percent higher than at the university (see section on parking costs). To put these percentages in perspective, only 1 out of every 55 respondents who commuted to Waikiki traveled by bus compared to 1 out of 8 commuters to the university. Only downtown Honolulu, itself, had a higher ratio of bus riders to commuters (1 out of 7).

Travel Time

Analysis of covariance, used to control for distance, revealed that automobile travel was 25 percent faster than bus travel ($p < 0.001$), according to respondents' estimates of their typical commuting times. Even though the majority of bus riders in the sample used express bus service, on average, a bus commuter traveled 1 mi in 4.4 min (approximately 13.6 mph), whereas a car commuter covered the same distance in 3.5 min (17.1 mph). The data do not permit separation of in-vehicle and out-of-vehicle travel time.

No direct relationship was found between travel distance and travel speed, but travel speed of car commuters was found to vary with respect to job location. The morning commute is slowest for people working downtown, and speed increases in proportion to the distance of job sites from downtown, in either direction. People who drove through downtown in the morning to get to job sites west of it had higher average speeds (25 to 35 mph, depending on distance) than those who drove to downtown (18 mph) or to areas within 2 mi east of downtown (18.5 mph).

The faster speeds of workers commuting through downtown in the morning is explained in part by the difference in home departure times of commuters. An inverse linear relationship was found between departure time and commute distance ($r = -0.26$, $p < 0.001$), with car commuters leaving 4 to 5 min earlier for each mile they have to travel. This suggests that people who worked west of downtown left earlier than other commuters in order to avoid traffic congestion. Presumably because of the slower speed of bus travel, bus riders left for work an average of 20 min earlier than car commuters ($p < 0.002$).

The distribution of departure times among car commuters in relation to work location with respect to downtown is shown in Table 1. On average, carpoolers left for work 20.4 min earlier than did solo driven (p c 0.003). Further analyses showed that almost 43 percent of morning commuters traveling toward downtown left home early enough to avoid the peak-hour traffic east of downtown between roughly 7:00 and 8:00 a.m. About 39 percent, mainly those working east of downtown, traveled during peak westbound (that is inbound) traffic, and the remaining 18 percent traveled after the peak hour.

Parking Costs

Only 37 percent of automobile commuters paid to park at or near their places of work, and in most areas of the island, 70 to 97 percent of workers parked free. In the major commercial districts of Waikiki and downtown Honolulu, however, about half of the car commuters paid for parking. Both the percentage of people who paid for parking and their average monthly cost for parking (the monthly price) were significantly higher in these two areas compared to all other work sites ($p < 0.001$).

As seen in Table 2, parking was one-third less expensive in areas adjacent to downtown (within 2 mi east or west of downtown), excluding Waikiki, and the percentage of car commuters that actually paid for parking was less than half that for downtown. Islandwide, the proportion of car commuters that paid for parking at work was inversely related to the distance of their work sites from downtown (biserial $r = -0.30$, $p < 0.001$). This relationship also holds for the price of parking ($r = -0.40$, $p < 0.001$)

Attitudes Toward TSM Strategies

The time of day that commuters traveled to work and the location d their work sites with respect to downtown each had significant effects on the attitudes of respondents toward various TSM strategies. Both of these effects were far more pronounced than were effects of respondents' mode of travel.

A thee-way ANOVA on morning time of travel (before. after, or during the peak traffic hour), work location (east of. west of, or in downtown), and travel mode (bus, carpool, or solo driver) found that time of travel and work location, but not mode, had major effects on the proportion of commuters interested in having flextime or staggered work hours, and in using express bus service. The results for work location and time of travel are presented in Tables 3 and 4 respectively. From 35 to 42 percent of commuters were interested in having flextime or staggered work hours on their jobs. depending on where they worked ($p<0.05$) and the time the usually left

TABLE 1 AVERAGE MORNING DEPARTURE TIMES FOR SOLO DRIVERS AND CARPOOLERS

Job-Site Location	Solo Driver	Carpooler
> 2 Miles East of Downtown	7:23	6:57
< 2 Miles East of Downtown	7:12	6:48
Downtown Proper	6:52	6:39
< 2 Miles West of Downtown	6:43	6:30
> 2 Miles West of Downtown	6:25	6:24

TABLE 2 PERCENT OF CAR COMMUTERS PAYING FOR PARKING AND AVERAGE MONTHLY COST

Location	Percent	Mean	S.E.M.
Downtown	51.7	$61.09	± 1.45
Downtown+ 2 Miles	21.9	$41.18	± 3.30
Waikiki	46.0	$47.30	± 2.19
All Other Sites	24.5	$25.44	± 1.40

- Downtown ± 2 Miles = 2 Miles East or West of Downtown.

TABLE 3 PERCENT OF COMMUTERS LIKELY TO USE VARIOUS TSM STRATEGIES BY JOB LOCATION

	Work Location		
TSM Strategy	East of Downtown	In Downtown	West of Downtown
Flex-Time/Staggered Hours	36.2	39.1	41.2 *
Park & Ride for Express Bus	23.3	29.0	21.0*
Park & Ride for Carpooling	16.1	15.3	16.6
Non-Family Carpooling	15.6	15.5	17.0

-Significant difference between categories

TABLE 4 PERCENT OF COMMUTERS LIKELY TO USE VARIOUS TSM STRATEGIES BY TIME OF TRAVEL

	Time of Travel		
TSM Strategy	Before Peak	During Peak	After Peak
Flex-Time/Staggered Hours	39.1	42.1	34.7*
Park & Ride for Express bus	26.2	25.1	19.7*
Park & Ride for Carpooling	16.3	16.4	12.9
Non-family Carpooling	17.6	17.1	11.0*

- Significant difference across categories.

for work ($p < 0.01$). Somewhat more car commuters (41.0 percent) than bus riders (32.3 percent) were interested in alternative work schedules, and solo driven (40.4 percent) showed slightly higher interest than carpoolers (37.2 percent), but these differences are not statistically significant.

Both commuters' time of travel ($p < 0.005$) and their work location ($p < 0.001$) had statistically significant effects on the likelihood of using park-and-ride facilities for express bus service, with downtown commuters and those traveling before or during the peak hour showing the greatest interest. This level of interest was attributable, in part, to those who were already bus riders (mainly downtown bus riders), 40.1 percent of whom said they were likely to use the facilities ($p < 0.005$) compared to 24.6 percent of solo drivers and 25.7 percent of carpoolers. Yet, even among car commuters ($p < 0.001$), those who worked downtown showed more interest (28.3 percent) than those working elsewhere (21.9 percent).

Lack of interest in using park-and-ride lots for carpooling was virtually universal, reflecting commuters' general resistance to carpooling with people from outside the *family*. Post-peak commuters showed significantly less interest than other commuters ($p < 0.05$) in park-and-ride lots. Nevertheless, car commuters recognized the potential time savings of high-occupancy-vehicle (HOV) lanes, and respondents in carpools with four or more people rated the value of HOV lanes quite highly.

Alternative Transit

The major purpose of this study was to determine potential demand for alternate modes of transportation that differ in service characteristics from normal bus service. Based on previous research (1,4,8), the two service characteristics of interest were a guaranteed seat and the distance of pickup and drop-off points from a commuter's points of origin and destination (refered to hereafter as access). The survey asked people to rate their likelihood of using alternative public transit or paratransit service, based on access, whether or not they were guaranteed a seat, and three hypothetical fares.

Time of travel, work location, and mode had significant but sometimes marginal effects on interest in using alternative transit or paratransit services. Overall, prepeak commuters were most likely to favor using such service ($p < 0.01$). Differences in interest between commuters traveling during and after peak were not statistically significant. No differences were found between downtown workers and those working west of downtown, and both of these groups were significantly more likely to use paratransit than people working east of downtown ($p < 0.05$).

Solo drivers and carpoolers appeared to be equally likely to use paratransit under all conditions posed. The primary effect of mode was for bus riders, who revealed an interaction between mode and fare and service characteristics. The percent of bus riders interested in paratransit exceeded that of automobile commuters only at a one-way fare of $1.00. Some 52 to 67 percent of bus riders were likely to use such service for a $1.00 fare if they were guaranteed a seat and access was comparable to current conditions. Potential ridership among bus commuters would increase to 74 percent if door-to-door service were offered at a $1.00 fare.

At a one-way fare of $2.00, interest among bus riders dropped to 20 to 29 percent even with a guaranteed seat (depending on access).

A $2.00 fare would be substantially more than the prevailing cost of commuting by bus for commuters who purchased a $15 monthly bus pass, which allows unlimited travel on Oahu's bus system. Pass holders were estimated to make an average of 2.9 daily weekday trips, so a $2.00 one-way fare would be more than seven times the current average trip cost of bus commuters, almost all of whom used monthly passes.

Although these findings, like those of other researchers (2), indicate that work site affects mode choice, this could reflect the importance of existing service conditions and may oot apply to transit having different service characteristics. Other variables, such as commute distance, might exert greater influence if geographical biases, such as centering service around downtown commuters, were eliminated. Because commute distance can exert a significant influence on transit ridership (2). independent of work location, analysis of covariance was used to partition out or statistically remove the variance attributable to commute distance. Bus commuters were excluded from these and subsequent analyses because of their small number.

This exercise substantially reduced the effects of time of travel and work location on commuters' professed likelihood of using alternative transit. Commute distance significantly ($p < 0.002$) affected potential transit ridership of both carpoolers and solo drivers in a positive but nonlinear fashion The percentage of automobile commuters (no reliable differences between solo drivers and carpoolers were found) likely to use paratransit was lowest (13 to 14 percent) among those traveling less than 5 miles each way to work. Interest jumped to 20 percent with commutes longer than 5 mi but increased only another 2 percent between 5 and 20 mi. At commute distances of more than 20 mi each way, interest in paratransit rose sharply again.

The effects of service characteristics and fare were more profound ($p < 0.001$ for each factor). Regardless of commute distance, a guaranteed seat increased potential ridership by roughly 7 percent, but each 5-min increase in access time (beyond door-to-door service) decreased prospective ridership 5 to 6 percent on average. Fare had the most powerful influence on commuters' likelihood of using paratransit, in that each $1.00 increase in fare produced a 12 to 13 percent decrease in potential ridership, all other things being equal. Significant two-factor and three-factor interactions among service variables and fare were found, however, implying that the effects of other things are neither equal nor inconsequential

Various combinations of distance, service factors, and fare can produce extremely high or extremely low ridership, as seen in Table 5. For simplicity, Table 5 shows only three of the five commute distances used in these analyses because scores were relatively stable for commutes between 6 and 20 mi long (includes groups 6-10, H-15, and 16-20 mi). Significance levels are not noted in the table because all main effects are significant.

The ubk reveals that wade-offs among service characteristics and fare an yield similar levels of ridership at different commute distances. Increases in service can compensate for losses in ridership that would occur with increases in fare. For example, at commute distances longer than 20 mi, 32.9 per-

TABLE 5 PERCENT OF AUTOMOBILE COMMUTERS LIKELY TO USE PARATRANSIT ON THE BASIS OF SERVICE CHARACTERISTICS FARE, AND COMMUTE DISTANCE

Commute Distance	Seating	Access	One-Way Fare $1.00	$2.00	$3.00
		Door/Door	33.2	18.3	8.4
< 5	Seat	5 Minutes	27.2	14.0	7.3
		10 Minutes	18.9	10.9	4.8
		Door/Door	24.6	13.0	5.0
< 5	No Seat	5 Minutes	20.5	10.5	4.7
		10 Minutes	13.3	7.8	4.3
		Door/Door	47.8	27.7	13.3
11-15	Seat	5 Minutes	41.1	22.0	9.3
		10 Minutes	30.8	15.7	6.4
		Door/Door	36.0	19.6	8.9
11-15	No Seat	5 Minutes	30.1	14.8	5.8
		10 Minutes	21.2	10.1	4.4
		Door/Door	50.0	33.3	20.3
> 28	Seat	5 Minutes	44.3	29.0	16.3
		10 Minutes	32.9	20.9	13.1
		Door/Door	39.7	25.9	14.3
> 20	No Seat	5 Minutes	34.8	21.5	11.1
		10 Minutes	24.5	14.0	7.7

* in Miles

* Seat = Guaranteed Seat; No Seat = No Guarantee of Seat

cent of automobile commuters were willing so walk 10 min to board paratransit at a $1.00 fare, if they were guaranteed a seat. A similar percentage (34.8 percent) were willing to walk only 5 min. at the same fare if they were not guaranteed a seat. At a $2.00 fare, both door-to-door service and a guaranteed seat would he required to attract roughly the same proportion (33.3 percent) of people commuting more than 20 mi. A comparable level of demand (33.2 percent) among people commuting less than 5 mi is achieved only with door-to-door service, a guaranteed seat, and a $1.00 fare.

Although commute time is related to commute distance the correlation between the two was relatively low (r =0.29) and the shared variance between these two factors varied from 3.6 to 13.6 percent, depending on mode. Because the time a commute takes to complete also encompasses some of the effects of the time of travel relative to the peak hour and mode, it would seem to be a potentially important variable affecting the likelihood of using alternative transit. Commute time produced a pattern of interest in paratransit quite similar to that found for commute distance: (a) low interest among those with commute times faster than 20 min, (b) a steep rise in interest among people whose commuting time was between 20 min. and 30 to 40 min, (c) a gradual increase in interest up to 40 to 50 min, and (d) a second sharp increase among those commuting longer than 50 min. In part, the similar pattern of results produced by commute time and commute distance may reflect the correlation between them. Although, as noted, the correlation was not high.

The relationships betweenm commute tune and the other variables tested (face. access, and seating) also mirror those found for commute distance, and significant main effects of all variables and interactions among all variables were found. Despite these commonalities interest in paratransit was greater at the highest levels of commute time than it was for commute distance, suggesting that travel time is more important than distance alone in attracting ridership. A more important difference between time and distance effects is that commute time has a significant interaction with seating that commute distance does not. Commute time is particularly sensitive to the value of a seat, and the value of a guaranteed seat increases systematically with commute time. Table 6 reveals how trade-offs among fare and service characteristics result in comparable levels of ridership at different commute times.

CONCLUSIONS

The results of the survey indicate a low rate of vehicle occupancy among commuters from the far eastern suburbs of Oahu. The vast majority of the people surveyed commuted by car, and the great bulk of these drove alone. Given these data, any efforts to increase vehicle occupancy seem worthwhile.

Only a small percentage of commuters were willing to carpool with people outside their own families, however (47). The existence of a parking facility that provides a central meeting place for carpoolers appears to offer virtually no incentive to carpool. Solo drivers were not interested in using these facilities, nor were current carpoolers, most of whom commute with family members. Even though people see the advantage of HOV lanes, the existing HOV/contraflow lane in Honolulu covers only a short distance (9). Apparently for most people, the time savings these lanes provide are outweighed by the burden of commuting with nonfamily memkn.

TABLE 6 PERCENT OF AUTOMOBILE COMMUTERS LIKELY TO USE PARATRANSIT ON THE BASIS OF SERVICE CHARACTERISTICS, FARE. AND COMMUTE TIME

Commute Time*	Seating*	Access	One-Way Fare $l.00	$2.00	$3.00
		Door/Door	25.5	17.0	12.1
< 20	Seat	5 Minutes	21.0	14.2	9.1
		10 Minutes	17.4	11.0	6.9
		Door/Door	21.4	13.7	8.3
< 29	No Seat	5 Minutes	18.7	11.4	5.2
		10 Minutes	12.8	7.9	3.9
		Door/Door	49.0	29.7	14.2
30-40	Seat	5 Minutes	41.9	23.1	11.6
		10 Minutes	31.1	17.0	8.0
		Door/Door	37.9	10.4	9.4
30-40	No Seat	5 Minutes	31.4	15.5	6.5
		10 Minutes	22.6	10.9	4.9
		Door/Door	49.7	31.6	17.6
> 50	Seat	5 Minutes	43.1	26.2	13.4
		10 Minutes	34.5	21.6	11.4
		Door/Door	38.1	22.8	12.4
> 50	No Seat	5 Minutes	32.3	18.9	8.8
		10 Minutes	94.0	13.2	6.7

• in Minutes

* Seat = Guaranteed Seat; No Seat = No Guarantee Of Seat.

Although interest in flextime or staggered working hours was high among various categories of commuters, morning departure times are distributed so widely already that any rigid institutional regimen of staggered hours is likely to cause considerable conflict with the usual travel arrangements of many commuters, as was found during the staggered working hours demonstration project with municipal, state. and other employees working in downtown Honolulu (10). Any such approach must be truly flexible, allowing commuters to adjust their departure times as they see fit.

Mode of travel had a significant effect on departure times, and departure times (presumably reflecting work schedules, with adjustments for other external influences) had significant effects on interest in using different modes of travel. Acting concurrently with these influences, and presumably interacting with them to some degree, work location with respect to downtown also affected departure time, mode choice, and the Likelihood of using available and potential transportation alternatives. These relationships probably reflect the fact that work location itself is related to a number of factors, including parking costs, commute distance, traffic congestion, and job density, that themselves provide incentives and disincentives for using various modes and that may limit potential carpool mates (2); Offered a transit alternative free of existing operating conditions and constraints such as transit's focus on downtown travelers, commuter interest was strongly influenced by basic factors such as commute time, service, and fare. Correspondingly, the effects of mode, time of travel (with respect to the peak) and work location appear to have less influence on interest in transit.

Potential ridership appears to grow with increases in commute time and distance. The influence of commute time in determining potential ridership would seem to be particularly important for providers of paratransit services because it implies that interest in transit that offers improved levels of service will rise as traffic congestion worsens. Improved service characteristics, such as guaranteed seating, significantly enhance ridership (4, 7). Guaranteed seating augmented potential ridership at all access times and could compensate for increased access times, at least up to 5 min. Beyond this distance, the time spent walking to pickup and drop-off points partially outweighed the value of a seat, but this trade-off depended upon commute time. For commuters traveling more than 50 min. for example, walking 10 min to boarding points to get a guaranteed seat was valued about as highly as having door-to-door service without guaranteed seating.

Of course, fare had a major effect on the likelihood that the commuters in this sample would use paratransit. All things being equal, potential ridership was affected more by fare than it was by either service variable studied, although this finding may not hold generally (1). Tables 5 and 6 make apparent the ability of the combined, positive effects of door-to-door service and guaranteed seating to overcome the negative effects of fare on potential ridership. Furthermore, the combined efforts of these service variables become more marked as commute time increases.

Can the type of service needed to attract alternative transit or paratransit ridership be profitable? The market appears to be strong enough to support a profit-making enterprise that can avoid the limitations and pitfalls of traditional transit operations (11-13). Existing computer technology seems to offer the solution to providing such service at low cost.

The innovative but inefficient dial-a-ride concept. which was first introduced in the 1906s (14, 15) should be combined with current computer technology to provide a real-time. demand-response transit alternative (M-28). A computer network, enabling communication between consumer and transit operators through a centralized system, could improve service at low cost. This network could not only offer immediate access to information about alternative transportation services but also would enable users to book a ride for any time, at any time, from the services available, on a trip-by-trip basis. Fares could be billed monthly by the central computer, saving on accounting costs (16, 17)

Access to the system need not be limited to consumers and operators of present day alternative transit or paratransit systems. Because the network would connect homes to a central computer, people seeking a ride could match their travel plans with those of people offering a ride. by posting appropriate information on an electronic bulletin board. This system would permit single-trip carpooling in its most convenient form--dynamic ridesharing without the time and information costs or personal commitment that often deter people from joining permanent carpools (5, 19, 20).

State and municipal governments should take measures to encourage varied forms of paratransit and make efforts to integrate information and transportation services.

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REFERENCES

1. **M. A. Kemp. Some Evidence of Transit Demand Elasticities. *Transportation*,** Vol. 2, 1973. pp. 25-52.
2. **C. B. Hamberger and A. Chatterjee. Effects of Fare and Other Factors on Express Bus Ridership in a Medium-Sized Urban Area. In *Transportation Research Record 1108*, TRB, National Research Council, Washington, D.C., 1987, pp. 53-59.**
3. **K. Neels and J. Mather. Modeling Mode Choice in New Jersey.** In Transportation Research Record 1139, TRB, National Research Council, Washington D.C., 1987, pp. 20-27.
4. M. S. McLeod Jr.. K. J. Flanelly, and B.H.K. Henderson. Commuting Behavior of Hawaii State Workers in Honolulu: Implications for Transportation System Mangeement Strategies In Transportation Research Record 1170. TRB National Research Council, Washington, D.C. 1988, pp. 53-59.
5. **K. J. Flannelly and M. S. McLeod, Jr. A Multivariate Analysis of Socioeconomic and Attitudinal Factors Predicting Commuters' Mode of Travel. *Bulletin of the Psychonomic Society*, Vol. 27, No. 1, 1989, pp. 64-66.**
6. **R. L. Winkler. *An Introduction to Bayesian Inference and Deci-*** sion. Holt, Riechart & Winston, New York, 1972.
7. K. J. Flannelly, M. S. McLeod, Jr., R.W. Behnke, and L. **Flannelly. Attitudinal and Behavioral Inclinations of Automobile Commuters Towards Alternative Modes of Commuting to Work.** Psychological Reports (in press).
8. G.J. Nicolaidis. Quantification of the Comfort Variable. Transportation Research Vol. 9, 1975, pp.55-66.

9. J. B. Margolin, M. R. Misch, and M. Stahe. Incentives and Disincentives of Ridesharing in Transportation Research Record 673. TRB, National Research Council, Washington, D.C.. 1978, pp. 7-15.
10. G. Giuliano and T. F. Golob, Evaluation of the 1988 Staggered Work Hours Demonstration Project in Honolulu: Find Report. Institute of Transportation Studies, University of California. Irvine. 1989.
11. R. Cervero. Intrametropolitan Trends in Sunbelt and Western Cities: Transportation Implications the Transportation Research Record 1067, TRB, National Research Council, Washington, D.C.. 1986, pp. 21-27.
12. D. T. Sik. Bus or Paratransit?: The Issues Involved. Transportation Planning and Technology, Vol. 10, 1986. pp. 305-322.
13. M. Wachs, U.S. Transit Subsidy Policy : In Need of Reform, Science, Vol. 244.1989, pp. 1545-1549
14. W. F. Hoey. Dial-A-Ride in the Context of Demand-Responsive Transportation: A Critical Appraisal. In Transportation Research Record 608, TRB, National Research Council, Washington, D.C., 1976, pp.26-29
15. E. Kadesh Evaluation of DRT Systems in Richmond and Santa Barbara. In Transportation Research Record 608, TRB. National Research Council, Washington D.C., 1976, pp. 42-47.
16. R. W. Behnke. A New Concept in Ridesharing for Honolulu. Report prepared for the State of Hawaii Department of Transportation. Aegis Systems Corporation, Portland, Oregon, Sept. 1982.
17. R. W. Behnke and M. S. McLeod, Jr. Videotex. Transportation and Energy Conservation. Presented at the Pacific Telecommunications Conference. Honolulu, Jan. 1984.
18 J. Collura, R. Bonsignore and P. McOwen, Computerized Management Information Systems for Transit Services in Small Urban and Rural Areas. In Transportation Research Record 936, TRB National Research, Washington, DC. 1983, pp. 60-68
19. J. Glazer, A. Koval, and C Gerar Part-Time Carpooling: A New Marketing Concept for Ridesharing in Transportation Research Record 1082, TRB, National Research Council, Washington, D.C., 1986, pp. 6-15
20. A. L. Kornhauser, P. Mottow, and B. Stephenson. Transportation. Efficiency and the Feasibility of Dynamic Ride Sharing. In Transportation Research Record 6550, TRB, National Research Council, Washington, DC pp. 43-48

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APPENDIX B

APPENDIX B

AUDIOTEX SYSTEMS

In this report, the term audiotex will be used to define any interactive computer system that uses touch-tone telephones as the primary input or output device. For those not familiar with this technology, it may be useful to review how a general-purpose audiotex system works and how a voice-response transit schedule information system works before reading the description of CST. The Sacramento Bee in California is one of over 30 newspapers in the U.S. that offers a variety of information services to the public via audiotex. The information below and on the following page is from a newspaper advertisement for BEELINE:

FIGURE 1

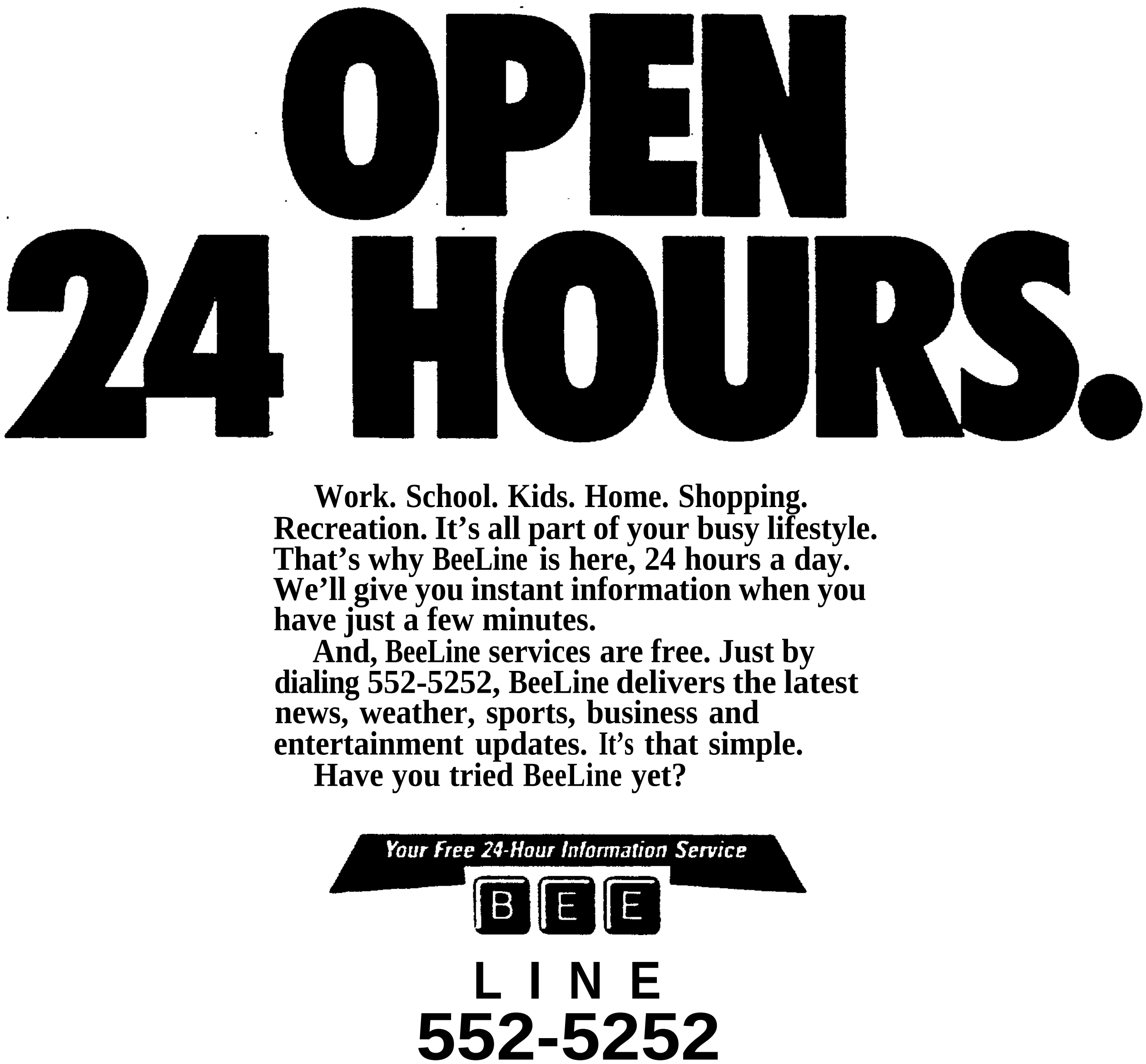

FIGURE 2

BEELINE DIRECTORY

Enter one of these codes for instant information updates:

News
2004 State & Local News
2005 Today's Breaking Story
1000 World News
1001 National News Report
1002 Business News Report
1004 Target: Point/Counterpoint
1005 Weekly Newsmaker
1007 Headline Story
2050 California Lottery Results
1242 Nat'l Lottery Results
4007 Sidetracks Teen Mailbox
4050 Discovery Science Mailbox

Business
3000 StockQuote Hotline
3001 How to Use StockQuote Hotline
2006 Local Mortgage Rate
2008 Local Corporate News
1015 Wall Street Stock Market Report
1016 New York Stock Market Report
1017 American Stock Market Report
1018 NASDAQ Stock Market Report
1019 Market Prices and Rates
1020 Bond Market Report
1021 Precious Metals Report
1022 Commodities Report
1023 Wall Street Business Headlines
1024 Wall Street Daily Money Report
1025 Wall Street Gold & Coin Report
1026 Standard & Poor's Stock Index
1027 Mutual Fund Report
1028 Most Active Stocks
1029 Top 10 Dollar Volume Stocks
1030 Top 10 Most Widely Held Stocks
1195 Daily Journal Quiz

Special Services
2000 How to use Beeline
2001 Main Directory
2002 Customer Service Line
2003 "Sound Off"
1243 Voice of the People
4003 Recycling Line
2007 Editorial Information Line
4012 Lesson Line

Music
1201 Country Singles
1202 Rock Singles
1203 R & B Singles
1204 AC Singles
1205 Jazz Albums
1206 Country Albums
1208 R & B Albums
1209 Top 10 Golden Oldies
1298 KZAP Rock Music World
1299 KZAP Rock Albums

Helpful Information
1246 Household Helper
1247 Vocabulary Power
1248 Weight Loss Guide

How to Use
Touch "G" (#4) to GO to a new category
Touch "B" (#2) to BACK-UP to the previous information item
Touch "J" (#5) to JUMP OVER current information item
Touch "R" (#7) to REPLAY the current information

Sports & Scores
1040 Sports Report
2013 San Francisco 49ers Line
2014 Sacramento Kings Line
2022 Local Sports
1042 NFL Football Scoreboard
1043 NHL Hockey Scoreboard
1044 NBA Basketball Scoreboard
1047 NFL Schedules & Standings
1048 NHL Schedules & Standings
1049 NBA Schedules & Standings
1045 NCAA Top 25 Scoreboard
1050 NCAA Top 20 Ratings
1051 Professional Tennis Report
1052 Professional Golf Report
1053 Professional Wrestling Report
2020 Fishing Line
2021 Boating & Rafting
4029 Ski Conditions
1192 Super Sports Quiz

Horoscopes
1100 Aquarius
1101 Aries
1102 Taurus
1103 Gemini
1104 Cancer
1105 Leo
1106 Virgo
1107 Libra
1108 Scorpio
1109 Sagittarius
1110 Capricorn
1111 Pisces
1112 Today's Birthdate
1113 Personal Galactic Forecast

Games, Quizzes & Challenges
1180 Adventure Challenge Menu
1181 Star Fleet Commander
1182 Treasure Quest
1183 Wizard Kingdom
1184 House of Terror
1185 Adventure Challenge of the Week
1191 General Quiz
1192 Super Sports Quiz
1193 Super History Quiz
1194 Really Tough Quiz
1195 Daily Journal Quiz
1197 Weekly Quiz Challenge

Movies, TV & Video
2040 Joe Baltake's Movie Reviews
1239 Hollywood Gossip Column
1249 Soap Opera Gossip
1216 Top 10 TV Shows
1217 Top 10 Movies
1231 NBC Tonight
1232 ABC Tonight
1233 CBS Tonight
1234 Fox Tonight
1235 Cable Tonight
1236 Best of...Worst of TV
1237 Best of...Worst of Cable
2041 New Video Releases
1218 Top 10 Videos

Health and Fitness
4019 Jenny Craig Weight Loss Guide
4021 Jazzercise

StockQuote Hotline Instructions

▶ To hear stock price, enter the Standard & Poor's ticker symbol on a touch-tone phone.

▶ Press two keys for each letter – first the letter key, then the number to indicate the position of the letter. (Example: IBM = "43" "22" "61") Press the asterisk when finished with the symbol. Press the asterisk a second time for volume, high and low.

● When finished with this category, press the one key, then the asterisk key to go to another BeeLine category. You will then be asked to enter a new category number.

For detailed instructions on how to use StockQuote Hotline, press category 3001. For your stock ticker symbol, call your broker.

Weather Forecasts
3010 Local Forecasts
3011 San Francisco
3012 Mother Lode
3013 Sierra
3500 Drought Hotline
2030 Highway & Road Conditions
1060 Anchorage
1061 Atlanta
1062 Baltimore
1063 Boston
1064 Buffalo
1065 Chicago
1066 Cincinnati
1067 Cleveland
1068 Dallas
1069 Denver
1070 Detroit
1071 Honolulu
1072 Houston
1073 Jacksonville
1074 Kansas City
1075 Las Vegas
1076 Los Angeles
1077 Miami
1078 Milwaukee
1079 Minneapolis
1080 Nashville
1081 New Orleans
1082 New York
1083 Orlando
1084 Philadelphia
1085 Phoenix
1086 Pittsburgh
1087 Portland
1088 San Diego
1090 Seattle
1091 St. Louis
1092 Tampa/St. Petersburg
1093 Washington, D.C.
1094 National Forecast
1095 Traveler's Forecast

Soaps
1250 All My Children
1251 Another World
1252 As the World Turns
1253 Dallas
1254 Days of Our Lives
1255 Twin Peaks
1256 General Hospital
1257 Generations
1258 Knots Landing
1259 LA Law
1260 Loving
1261 One Life to Live
1262 Santa Barbara
1263 Bold and Beautiful
1264 Guiding Light
1265 Young and Restless
1266 Thirtysomething

Local Entertainment
2060 Local Concerts
2061 Local Theatre
2062 Local Events
2063 Local Clubs
4321 Bee Events

552-5252

Figure 4-2 provides a directory of BEELINE information services. Readers are encouraged to try this service from both a touch-tone telephone and from a rotary-dial phone to get practical experience on a general information audiotex system. Those who are calling long distance must dial area code (916) before they dial 552-5252. When the BEELINE computer asks for a four-digit information category code, for example, enter "2030" for Caltran's Highway and Road Conditions or "1242" for National Lottery Results. During this audiotex trial, readers should also try to find the price of IBM stock via BEELINE's Stock Quote Hotline to see how difficult it is to enter alphabetic information via a touch-tone telephone keyboard.

A touch-tone telephone user must make two keystrokes for each alphabetic character. The first digit indicates that number of the button on the touch-tone keyboard where the letter is located, and the second digit indicates whether the letter is the first, second or third of the three letters on that button. For example, the letters "GHI" are on button number "4". Therefore, G is represented by "41", H is represented by "42" and I is represented by "43". The letters "Q" or "Z", which do not appear on touch-tone telephone keyboards are represented by "01" and "03", respectively.

Those who tried to use BEELINE from a rotary-dial telephone (or who told the BEELINE computer that their touch-tone telephone was a rotary dial phone) found that they had a more limited menu of information services. These services can only be accessed by, saying "YES" when asked if they wanted a specific service. The BEELINE computer system treats almost any sound that the user makes during a short'interval after a YES/NO question as a "YES", and the absence of a sound as a "NO". This binary approach means that four-part multiple-choice questions must be restated as a series of YES/NO questions and that the entry of alphabetic information would be extremely slow and impractical from a rotary dial phone. However, this may change in the future with the addition of voice recognition subsystems that can identify the ten digits, the 26 letters of the alphabet and some commonly used words. A number of companies have already demonstrated good voice recognition capabilities when using quality phones and quality communications lines.

Tri-Met, the public transit system operator in Portland (Oregon), has implemented audiotex systems for its light rail ((503) 22-TRAIN') and its bus ((503) 231-3199) services. Both of these audiotex-services provide callers with access to transit schedule information. Callers may wish to use a touch-tone phone to find the departure time of the next MAX (i.e. light rail) train between

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'The author disclaims any responsibility for this difficult to forgive/forget pun.

Gresham and Lloyd Center. Gresham is the last and most easterly stop on the MAX light rail transit (LRT) line and Lloyd Center is a large shopping center in the northeast part of the city,

Readers are also encouraged to use or simulate the use of a rotary dial phone to find the departure time of the next bus on Route 56 (Scholls Ferry Road) from Washington Square, a large shopping center in the southwest part of the city, to the Portland Mall downtown. The first part of the "Call-A-Bus" information service will ask you to redial (503) 231-3256, where the last two digits "56" are the route number. Callers may also see how the voice response feature operates by saying "SUNDAY" or something else when the computer asks you to say "SATURDAY". Tri-Met's "Call-A-Bus" information system was designed to appear conversational, but in reality it too only detects the presence or absence of a sound, not a specific word, during a small time interval after the "beep" to lead the caller through the telephone-based bus schedule information system.

Readers who have accessed either the Sacramento Bee's BEELINE, one of Tri-Met's transit schedule information systems, or another audiotex system will understand that obtaining. information for audiotex systems can be very time consuming. To find the scheduled time of departure of the first bus after 9 A.M. on a weekday on Route 56 between Washington Square and downtown Portland, for example, requires entering the following ten items with a touch-tone telephone keyboard:

1. Computer says: "Route 56-Scholl's Ferry Road Line. Press 1 if you are calling from a touch tone phone; wait if you are calling from a rotary dial phone". (Pressed " 1")

2. "Press 3 if you are heading to downtown Portland or 9 if you are heading away from downtown Portland." (Pressed "3")

3. "Press the following for the schedule information desired: 1 for weekdays, 2 for Saturdays, 3 for Sundays and holidays. For travel times or Route 56 press 9." (Pressed "1")

4. "For wheelchair accessible trips, press 1, -otherwise press 2." (Pressed "2")

5. "For destinations beyond Burnside and 6th press 1, othewise press 2." (Pressed "2")

6. "Press 1 if your origin bus stop is between Washington Square and Beaverton-Hillsdale Highway. Press 2 if it is between Sunset and Capital Highway and Front and Harrison, etc." (Pressed "1")

7. "Press 1 if your origin bus stop is Washington Square." (Pressed "1")

8. "Enter the hour closest to your departure time. (e.g. enter 11 for either 11 AM or 11 PM)." (Pressed "11")

9. "Press 1 for AM, Press 2 for PM." (Pressed "1")

10. "Departure times are 10:20; 10:50; 11:20. Press "1" to repeat departure times." (Pressed "1")

To speed up the inquiry process, some audiotex systems have added "magazine" features for special subscribers. After a subscriber calls 'a special telephone number, the audiotex system asks the subscriber to enter his or her account number and password. If this is done correctly, the audiotex system presents the answers to a set of the subscriber's prerecorded inquiries, such as: (a) What was the score of the most recent Sacramento King's game? (b) What was the last price of the common stock of Hewlett-Packard, INTEL and IBM? (c) What is the weather forecast for today? (d) What is the-latest traffic congestion report on I-5? . . . . . without any additional input by the caller.

The subscriber can add, modify or delete inquiries in his or her magazine at any time. The use of prerecorded inquiries greatly simplifies the use of audiotex systems for frequent users,. The use of a password or personal identification number (PIN), provides improved security features for sensitive information or business transactions (e.g. to request checking account, savings account, credit and frequent flyer balances or to make airline, hotel or restaurant reservations), particularly when combined with Automatic (telephone) Number Identification (ANI) and other security procedures.

The ability to pre-store commonly used codes, requests for information, etc. in modern audiotex/voice response systems and the wide spread availability of touch tone phones makes this technology a powerful tool for CST and other Advanced Traveler Information Systems (ATIS).

APPENDIX C

APPENDIX C

VIDEOTEX SYSTEMS

Videotex is the term used to describe a variety of easy-to-use, two-way consumer information systems. Users in homes, offices and shops can call information from a variety of remote computers and display it on video screen using a low-cost, microcomputer terminal. The information can be transmitted between the videotex terminals and the remote computes by telephone line, TV cable or radio links. The following is a typical French "Mintel" videotex terminal:

A new and unique communications medium, videotex has tremendous potential in both the residential and business markets. Included in its many services are electronic banking, teleshopping, advertising, computer-based education, interpersonal messages, entertainment features and specialized information retrieval -- services that have a wide appeal to consumers interested in efficient, time-saving methods of communications. Videotex terminals cannot only deliver and receive textual materials, they can also display graphics with a broad range of color capabilities.

APPENDIX D

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Meetings Summary

1. Caltrans District: 3 Name: MARYSVILLE

2. Key findings:

   The traffic congestion problems of the Sacramento'area are less severe than those of San Diego, Los Angeles and San Francisco. Roseville, however, looks like a good ATIS/parataXi test Site. It was suggested by local Caltrans prsonnel.

3. Meetings with the following Caltrans 'personnel:

   Brian Smith, Deputy District Director, Planning and Public Transportation
   George Smith, Chief, New Transit Technology
   Jeffrey Pulverman, Chief, Caltrans Sacramento Rideshare - Sacramento Rideshare Staff

4. Meetings with the following local government/transportation personnel:

   Barbara Lindsey, Executive Director, South Placer County **TMA**
   Paul Williams, Manager Commute Systems, PacBell
   Patricia Mokhtarian - U.C. Davis

5. Meetings with the following computerjtelecommunications personnel:

   Frank Dorf - the Sacramento Bee (audiotex services)
   Brent Vance - PacBell Account Manager for Caltrans in Sacramento
   Keith Epstein, Jeff Richards, External Affairs, PacBell

6. Additional comments:

   Aegis conducted several slide presentations in the district. Also had telephone conversations and meetings with users of Brite Voice Systems; Inc. audiotex systems (i.e. the type used in BeeLine) to determine its strengths and weaknesses for ATIS/parataxi applications.

Meetings Summary

1. Caltrans District: 4 Name: SAN FRANCISCO

2. Key findings:

   There appears to be a strong interest in testing out the ATIS/parataxi concept in the San Francisco Bay Area. The Tri-Valley Area in the East Bay appears to be an excellent test site. It was recommended by local Caltrans personnel.

3. Meetings with the following Caltrans personnel:

   - George Grey, Deputy District Director
     Wade Green, Engineer
     Bruce Couchman, Transportation Planner

4. Meetings with the following local government/transportation personnel:

   John Eells, Transportation Planning Coordinator, Marin County
   John Dillon, Transportation Manager, City of San Ramon
   Gail Gilpin, Transportation Manager, City of Pleasanton
   Jeff Lindley, FHWA, San Francisco Office
   Mallory Nestor, Manager Accessible Services, Central Contra Costa Transit Authority

5. Meetings with the following computer/telecommunications personnel:

   Keith Epstein, Jeff Ricards, External Affairs, PacBell
   Walter Fleming, Rich Artusy, US West, Public Safety Group
   Williams Bing, Graeme Kinsey, VOTAN (voice response systems)
   Dan Condron, Ellie McGovern, Jerry Cushman, Hewlett Packard
   Stephen Wollenberg, President, Traffic Info NOW!
   - Ernest J. Conway, Pulse Com Partners

6. Additional comments:

   At the request of Caltrans, project personnel met with *several* representatives of the Lawrence Livermore Radiator Laboratory to discuss their possible participation in an ATIS/parataxi demonstration project. Both Pleasanton and San Ramon were extremely interested in participating in an ATIS/parataxi demonstration project. Their traffic mitigation ordinances need additional help; AVO rates are increasing.

<u>Meetings *Summary*</u>

1. Caltrans District: 7 Name : LOS ANGELES

2. Key findings:

   There appeared to be a Strong interest in testing out the ATIS/parataxi concept in the L.A. area. UCLA/Westwood and Simi Valley were strongly recommended a potential test sites.

3. Meetings with the following Caltrans personnel:

   David Roper, Deputy District Director, Operations
   Lew Bedolla, Deputy District Director. (Planning and Public Transportation
   Joseph Gilly, Senior Transportation Planner
   Kathy Gerwig, CTS/Commuter Computer
   Robert Kohl, EDP Manager, CTS/Commuter Computer

4. Meetings with the following local government/transportation personnel:

   - James McLaughlin, Acting Chief of Transit Programs, City of Los Angeles
   - Alan Bowser, Principal TDM, Southern California ASSn. of Governments (SCAG)
   - Richard DeRock, Project Manager San Fernando/North County Area Los Angeles County Transportationcommission (LACTC)
   - Shahrzad Amiri, Project Manager, Westside Area, LACTC
   - Michael Appleby and Steve Mazor, Auto Club of Southern California
   - Donald Camph, Executive Director, El Segundo TMA
   - Judith Norman, Transportation Programs Manager SCAQMD
   - Charles Coffee, Executive Director, Simi Valley TMA
   - Martin Wachs (Professor), Mark Stocki (Director Business and Transportation Services); Jack Schwab (EDP Systems UCLA).

5. Meetings with the following computer/telecommunications personnel:

   - Ken Phillips, Director, Information Systems Department City of Santa Monica
     Ronald Emerling, President, VoCal Telecommunications voice response systems designer/developer

6. Additional comments:

   Behnke and Snyder conducted eight slide briefings in the district. There appears to be a growing recognition that Los Angeles will not be able to meet Regulation XV goals without new technologies.

Meetings Summary

1. Caltrans District: 11 Name: SAN DIEGO

2. Key findings:

   The North City TMA recommended by local Caltrans personnel would be an excellent test site. It is a fast growing suburban business center with very limited public transportation services and rapidly growing. congestion problems.

3. Meetings with the following Caltrans personnel:

   Carl R. West - Deputy District Director, Planning and Public Transportation
   Manuel Dimitre - Program Director, Caltrans Commuter Computer
   Commuter Computer staff

4. Meetings with the following local government/transportation personnel:

   Timothy Price, Senior Transportation Planner, Metropolitan Transit Development Board (MTDB)
   George Franck,Senior Transportation Planner, San Diego Assn. of Governments (SanDAG)
   Bob Goggin, Manager Public Information, Air Pollution Control District (APCD)
   Ann Cooley Darh, Executive Director, North City TMA
   Board members and staff of North City TMA

5. Meetings with the following computer/telecommunications personnel:

   - Louise Courtier, Emerson and Stern Associates
     New Voice recognition technologies
     Paul Bouchard (President) and Donald Murphy (Director of Business Development) - IVHS Technologies Inc.

6. Additional comments:

   - Aegis conducted several slide briefings in the area. There appears to be a strong interest in low-cost TDM approaches since the San Diego Area has the fastest growing traffic congestion index (i.e. problem) in the U.S.A.

Meetings Summary

1. Caltrans District: 12 Name: ORANGE COUNTY

2. Key findings:

   This area does not seem to have the sense of urgency or the willingness to test new concepts found in either San Diego or Los Angeles. Local Caltrans personnel suggested Irvine as a test site.

3. Meetings with the following Caltrans personnel:

   Dale Ratzlaff, Deputy District Director, Planning and Public Transportation
   Joe Hecker, Chief, Traffic Management Branch
   Dorothy Uzehara, Chief, Public Transportation, Ridesharing and Analyses Branch

4. Meetings with the following local government/transportation personnel:

   Douglas Reilly, Executive Director, Strategic Transportation
   Ami Amerani, Senior Engineer, Transit Planning, City of Irvine
   Kenneth Takeda, Manager, Commuter Network, Orange County Transit District (OCTD)
   Ralph Shafer, Transportation Manager, Leisure World, Laguna Hills
   Orange County TMA managers

5. Meetings with the following computer/telecommunications personnel:

   - Oliver Thurman III, President, Global Engineering

6. Additional comments:

   - Aegis conducted several slide presentations in the district. USDOT/UMTA authorized several million dollars to evaluate concepts that could improve the mobility of the disabled. A proposal was submitted to study the applicability of ATIS/parataxi concepts in the Leisure World senior citizen community. The proposal made the first cut but not the second by Washington D.C. - based Project ACTION.

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